The Socialization of Indian Scientific Writers Into Western Scientific Discourse Communities.

Sumita Roy

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THE SOCIALIZATION OF INDIAN SCIENTIFIC WRITERS INTO WESTERN SCIENTIFIC DISCOURSE COMMUNITIES

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in

The Department of English

by

Sumita Roy
B.A., University of Calcutta, 1983
M.A., University of Calcutta, 1986
M.A., Louisiana State University, 1996
May 1998
To my parents,

Dinabandhu and Tapati Lahiri,

who taught me to read and write.
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ABSTRACT

This research studies the socialization of Indian science writers into western discourse communities. More specifically, it seeks to identify the writing problems that beginner Indian science writers face and the strategies that they adopt in overcoming them while writing dissertations or research articles.

Primary information was gathered by interviewing 11 Indian graduate students and 17 faculty members from India (West Bengal) and the USA on the basis of a five-page questionnaire. Respondents were classified into three groups according to their places of training and writing skills. Three to five sets of rough drafts from each group were studied to note textual revisions and review comments as a supplementary source of information. A fourth group consisting of five native-speaking faculty members was also interviewed on the basis of a separate questionnaire.

This research demonstrates that while beginner Indian respondents share many problems with other nonnative and native speakers alike, their problems have roots in Indian culture and education. These factors merit consideration for future pedagogical instruction. Variable language policies and schooling systems produce students with varying writing proficiencies. Initial training in the text-based reproductive and authoritarian mode combined with a heavy literary emphasis is viewed as an obstacle towards writing an effective argument or a critical synthesis. Problems such as validating claims and inferences arise from weak rhetorical skills and a lack of awareness for the rhetorical organization of the traditional Introduction-Method-Results-Discussion format in scientific writing, including the role of citations as a rhetorical tool. Cultural traits such
as providing contextual information combined with a lack of scientific writing instruction produce digressive writing. While unlike other nonnative writers, beginner respondents write drafts in English, their minor but recurrent problems include ineffective sentence construction, repetition, flowery language, weak cohesion and incorrect article use. Planning extensively, using mathematical language, extending vocabulary, and writing shorter sentences are identified as successful strategies that are adopted to overcome writing obstacles. Reading and using advisorial feedback are other beneficial strategies that facilitate the socialization process. Writing instruction on developing critical, argumentative and rhetorical skills is recommended as a corrective pedagogy.
CHAPTER I
INTRODUCTION

BACKGROUND

Recent research has shown that the number of foreign graduate students in science and engineering programs in most universities in the USA is escalating (Hill et al. 1982; Kroll 1985; Huckin and Olsen 1984; Parkhurst 1990; Jenkins et al. 1993; Tucker 1995). In 1982, the American Council of Education’s Committee on Foreign Students and International Policy predicted that by the early 1990's, well over a million foreign-born students would be enrolled in American institutions for higher education (Scully 1981). Foreign students, who are more numerous than American students in graduate programs in science and engineering, were granted 37.9% of the doctoral degrees in science and engineering in 1991 (Leatherman 1992). The American Association of Engineering Societies reports that foreign students constitute 50.1% of the total enrollment in the doctoral programs and 39.6% in the master’s programs (Engineering Manpower Commission 1991). According to a report published in the Annual Meeting of the American Educational Research Association, foreign graduate student enrollment in science and engineering from Asian countries will continue to grow in doctoral programs in American research institutions (Johnson 1993). Typically, one out of every three of these graduating foreign students stays in the United States for gainful employment (Greer 1983).

One implication of such a phenomenon is that though a majority of these foreign students have received instruction in English for several years in their native countries and

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have satisfactorily fulfilled the requirements of English proficiency tests, they often
display a weak command of English in communicative and "productive skills" (Huckin
and Olsen 1984). In spite of possessing excellent mathematical and problem-solving
abilities, these international students reveal varying "levels of preparation in English"
(Tucker 1995). A survey of the recent American Society for Engineering Education
journals such as Prism and Engineering Education indicates that scant attention has been
paid towards enhancing the writing skills of graduate students (Jenkins et al. 1993),
especially those of nonnative writers (Casanave and Hubbard 1992). Hence, many
nonnative engineering students find it difficult to write their theses (Buell 1991; Cadman
1997). Research also shows that engineers are involved in considerable writing (Winsor
1990), and that good communication skills are deemed crucial for "professional success."
(Jenkins et al. 1993).

Proficiency in written English is crucial, since in the last 50 years English has
become the principal language of transmitting and exchanging information in science and
technology. Over half the scientific articles produced by the international scientific
community are written in English (Wood 1967; Baldauf and Jernudd 1983; St. John
factors, has been attributed to the "role played by the American research organizations in
the progress of science and technology" (Tarantino 1991: 47). Since English is the
international language for science and technology, both within and outside academia, it is
important that we understand the processes by which nonnative students are effectively
socialized into scientific discourse communities as writers. However, a review of available
literature indicates that there is inadequate documentation on the writing processes of nonnative science writers.

**English for Science and Technology (EST) and Non-Native Speakers**

The variety of English used in scientific contexts is usually referred to as English for Science and Technology (EST) (Trimble 1985). Through EST, scientists and students of science from different linguistic and sociocultural backgrounds explore, discover, and evaluate scientific truths. Many scientists in the non-English speaking world prefer to publish in English rather than in their native language to gain a wider international readership (Swales 1990).

EST is characterized by its rigid rhetorical structure, use of passive sentences, allocation of the paragraph as the functional unit, and use of compound nouns (Trimble 1985; Halliday 1967; Tarantino 1991). Although the textual features associated with any specific genre may have no "fixed definition" (Bazerman 1988), the social processes of "institutionalization" of representation within the academy of science have given rise to certain accepted conventions. Most important are the standard Introduction-Method-Results-Discussion (IMRAD) organizational format where the methodology is presented after the introduction, but before the results and the incorporation of literature and citations within text (Bazerman 1988; Swales 1990). Since the purpose behind all significant scientific communication is not just the publication of results but also to persuade or convince other scientists that the claims made therein are valid, EST is clearly
rhetorical\(^1\). As part of this overall persuasive purpose, conventional format and style in scientific writing demand the use of "formal technical language" to show the "professional competence" of the author, citations of appropriate literature to validate the basic assumptions of the scientific research and to indicate its continuity with or departures from established scientific methodologies, and use of the passive voice in the "theoretical arguments" and reporting of experimental data to show objectivity (Ziman 1984). Lately, however, the use of passive voice in scientific writing has been disputed (Perlman 1996). As Ziman further suggests, from an "epistemological point of view" the use of the conventional format and style in scientific writing is a necessary step in the production of "testable" or verifiable scientific generalizations.

Academic science and technology practitioners thus form a distinct if varied discourse community, which Swales in *Genre Analysis* (1990), describes as "sociorhetorical networks that form in order to work towards sets of common goals. One of the characteristics that established members of these discourse communities possess is familiarity with the particular genres that are used in the communicative furtherance of those sets of goals" (9). Referring to Bizzell (1982), he suggests that student academic writing is not only a product of an "inner-directed cognitive process" but also an "acquired response to discourse conventions which arise from preferred ways of creating and communicating knowledge within particular communities" (4). Since discourse in

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\(^1\) Despite a certain amount of umbrage from the scientific community (Macilwain 1995) and controversies about the rhetorical nature of scientific writing (Gross 1993), it is assumed for the purposes of this study that scientific writing is rhetorical since it is primarily genre-based.
scientific communities is “socially situated” and is devised to “achieve certain rhetorical goals,” not only must language be used in a particular way, but scientific facts must also be arranged in a particular way.

The acquisition of EST has often proved difficult for the scientist with English as a Second Language (ESL) background. A recent article on analyzing different ways of coping with “intercultural problems” while writing EST suggests conducting textlinguistic research to study the “linguistic and cultural differences” between English and the native language of the nonnative speaker (Ventola 1992). A survey of the literature on international scientific writing, however, suggests that not much research has been done towards documenting the writing strategies (in a broad sense) of foreign-born science writers in this country. The few studies that have been conducted in the UK, Europe, Australia and lately in the USA suggest that science writers with an ESL background tend to have difficulties with problems like tense use (Parkhurst 1990; Shaw 1991), native language interferences (Master 1991), and the use of the third person singular ‘s’ (Abraham 1984). Nonnative speakers have also been found to indulge in meticulous planning and often write bilingual drafts (St. John 1987). Most nonnative speakers express difficulty in writing the Introduction and Discussion sections of their reports because of a lack of complex rhetorical skills (Shaw 1991; St. John 1987). A few other studies situate certain writing problems such as weak rhetorical and argumentative skills and poor use of textual cohesive devices to cultural differences (Ventola 1992; Sionis 1995; Ballard 1984; James 1984; Fox 1994; Cadman 1997). Generally speaking, however, studies of the language practices of nonnative speakers are still in their infancy.
Although most graduate programs in American universities expect good writing skills from their students, professors, in practice, spend little effort in addressing the writing needs of such students (Jenkins et al. 1993). Casanave and Hubbard (1992) suggest that although nonnative doctoral students are able to fulfill the requirements of their written assignments, they lack "overall writing ability." While students in science and engineering, like their counterparts in the humanities and social sciences, are also required to produce "extended pieces" of writing such as research reports, the fact that these are liberally sprinkled with charts, figures and graphs perhaps camouflages writing deficiency (Casanave and Hubbard 1992). While these studies provide us with some useful information about the writing behaviors of nonnative writers, they are inadequate for the purposes of this research, since we cannot extrapolate these findings specifically to the Indian context.

The purpose of this dissertation is thus to study and observe the writing behaviors and problems of one such group of Indian writers of English who generate substantial amounts of scientific texts in the form of theses, dissertations, journal articles, and proposals within academia. It will attempt to delineate the typical rhetorical and other writing strategies\(^\text{2}\) that they adopt or devise in order to write successfully in the larger scientific community. It will also, whenever possible, suggest the Indian roots of their problems with EST, even problems shared with other science writers. Since recent studies

\(^2\) I use the term "rhetorical and other writing strategies" in a broad sense, where I study the rhetorical and organizational features of texts. It also includes identification of writing problems that the writers have to sometimes cope with, namely, incorporation of citations within the text, development of argumentative skills and vocabulary/word choice and grammatical concerns.
in the sociology of science have posited that writing in science is predominantly a social act (Bazerman 1988; Bruffee 1986; Myers 1990; Latour and Woolgar 1979), my theoretical assumptions for this research will be based on a social analysis of language use in science.

The Writing of Indian Scientists

As will be explained in more detail in Chapter IV, Indian scientists trained in the USA or UK can be skilled writers who generate a rather impressive number of publications, yet, although India has the second largest scientific and technical human resources in the world, the number of research publications from scientists in India itself in international scientific journals is low (Swales 1985; Ramani et al. 1988). Scientific American, in a recent survey of 3,300 international journals included in the Science Citation Index (SCI), reports that only 1.64% of the total contributions came from India (Gibbs 1995). In an analysis of authored publications in the journals covered by the SCI between 1981 and 1995 in a letter addressed to the editor of Nature, Raghuram and Madhavi note that the Indian contribution to international scientific publication has declined by 32% (Raghuram and Madhavi 1996). Since the basic social institution of science is its system of communication, it is obvious that scientific research in Third World countries such as India is not "linked by citation" to research in the First World. Although there is a possibility that significant research from Third World countries is "under-represented" in the SCI database (Swales 1990), Raghavan and Madhavi (1996) attribute only one-third of the overall decline to such a factor. The Indian preference for publishing research in international journals in English and the comparative increase in scientific output from
neighboring South-East Asian countries and China make the figure somewhat disquieting. If knowledge-making and writing in science are construed as communal activities, we may assume that scientists in the same discourse community, irrespective of their primary cultures, share a common set of assumptions about scientific hypotheses, beliefs, methods, procedures and goals. Yet, as we see from the publication records of scientists working in India, that it is not always the case.

While some leading Indian scientists working in India feel that biases about Third World research act as an exclusionary tactic, editors of international journals cite substandard research, poor language skills and grammatical and spelling errors as some of the reasons for rejecting scientific articles from Third World countries such as India (Gibbs 1995). In a survey of 136 native-speaking science editors, 74% suggested that the “value and quality” of research conducted by nonnative researchers may be “disguised” due to ineffective communication skills (Gosden 1992). It is also significant to note in this context that an article on designing a technical writing syllabus in a premier research institute in India underlines the need for providing students with instruction in writing the Method section (Ramani et al. 1988), in an attempt to remedy such writing deficiencies.

In examining this problem, Bazerman’s (1988) interpretation and application of Vygotskian principles explaining how “neophyte” writers are socialized into discourse communities provide an appropriate scaffolding for understanding how beginner Indian science writers with poor language skills (cited by Gibbs, 1995) can transform or socialize themselves into active participants as productive writers, once they are placed within the environs of academic discourse communities in the USA.
While the absence of any other documentation on the writing behaviors of Indian scientific writers makes interpretation of their writing patterns difficult at this point, this absence indicates that it is an area ripe for investigation. The fact that a large number of Indian students are enrolled in science and engineering schools in most American universities further enhances the need for this study, especially if workable pedagogical techniques can be suggested as partial remedies. According to the Institute of International Education's "Open Doors 1995-1996" report, and an article in The Chronicle of Higher Education, Indians constituted the fifth largest group of nonnative foreign students in the American universities (31,743 out of a total of 453,787 foreign students) during the period 1995-1996 (Davis 1996; Desruisseaux, 1996).

STATEMENT OF OBJECTIVE

This study explores how beginner Indian scientific writers learn to write a dissertation or a scientific article in the USA; or, in other words, in attempting to write according to the demands of their discourse community, what writing problems do beginner Indian science writers encounter and how do they overcome them? Since there is very little technical/scientific writing instruction in most Indian colleges and universities and since there is a lack of a publication culture in India, I would like to address certain sub-questions as part of my larger research focus:

• What specific problems do Indian students face as dissertation writers? How does a beginner Indian science writer learn to write a scientific article?

• Do Indian science writers consciously change their rhetorical strategies once they are in the USA, i.e., how do they develop from an unskilled to a skilled writer?
Which of the problems faced by beginner Indian science writers can be traced to their cultural and educational roots and which are typical of most novice science writers? Which of these problems shared by Indian and non-Indian science writers are on the surface identical, but actually arise from different causes?

I will attempt to provide a perspective on how the cultural and educational background of Indian graduate students affects their scientific writing. I will also attempt to evaluate the conclusions of my research in the broader context of what is available in terms of published literature on other nonnative and native science writers.

**Aim and Scope**

This study has two limitations in scope which must be noted at the outset. First, although the word “process” might imply a step-by-step narration of events, it is not entirely possible to document the “socialization process” of beginner writers in clear-cut stages and arrange them in a chronological pattern. Given the different academic discourse requirements between India and the USA, my aim is to identify the specific writing problems beginner Indian science writers encounter in the USA and to document certain writing strategies that they adopt to overcome them.

Second, the conclusions derived from this study should not be taken as generalized statements on the writing proficiencies of all Indian science writers. My conclusions are based solely on the findings obtained through the interviews conducted for this study. This caveat is necessary since due to a variety of historical, educational, social and cultural reasons, Indian writers on a continuum acquire differing levels of writing skills in English. A quantitative study measuring such variables as language group, schooling,
ethnic background, and social status is highly desirable, and it is hoped that this dissertation will facilitate such a study in the future.

Overview

To find out how beginner Indian science writers socialize themselves into western discourse communities, I interviewed 11 beginner (dissertation writers) and 17 skilled (faculty members) Indian science writers in India (West Bengal) and the USA (mostly, at the Louisiana State University, Baton Rouge). The interviews were based on a five-page questionnaire. To ease the information-gathering and interpretation process, I classified the writers into three groups. A core set of three to four rough drafts for dissertations or journal articles from each of these three groups was also studied. A fourth group comprised of five native-speaking faculty members from departments in science and engineering that have a large number of Indian graduate students at Louisiana State University (LSU) was also interviewed through a separate questionnaire for supplemental information.

This research demonstrates that despite the tradition of English studies in India that began in the mid-eighteenth century, due to a unique blend of educational, linguistic, cultural and historical factors, beginner Indian science writers upon their arrival in the USA reveal varying writing proficiencies and deficiencies that are sometimes uniquely Indian. While for some beginner writers it is relatively easy to socialize themselves into western academic discourse communities due to excellent and compatible schooling in India, for many others socialization involves disassociating from the discourse mode prevalent in Indian academic English and undergoing what has been called a “double
cultural shift." This shift includes learning to switch from a predominantly authoritarian text-based “reproductive” instruction system towards a more “egalitarian” western discourse mode where developing a “point of view” is considered crucial in augmenting a critical argument. But, more than that, the shift requires the novice writer to recognize that good scientific writing is strongly rhetorical and is aimed towards gaining a “rational consensus” within the scientific community. Typically, thus, most beginner Indian science writers tend to find writing the more persuasive aspects of the Introduction and Discussion sections, with their emphases on justification, substantiation and establishment of claims, somewhat difficult.

Other related problems noted in the survey and literature review include effecting critical syntheses of published literature and incorporating them at appropriate junctures within the text with a view towards illustrating either continuity or departures of present work with or from established scientific traditions. Repetition, use of flowery language, and a tendency to include what appears to the western eye as a sense of “indirection” or redundant material in the form of “background” material are also common in beginner Indian scientific writing. Inadequate use of cohesive words or reference markers and tenses are also considered problematic. Characteristic writing strategies include an over-reliance on mathematical equations, charts and figures; tendency to over-quote or use a “list of useful words and phrases” from published literature; and use of extensive planning.

It is hoped that this study will provide fertile research material for future investigators for devising writing instruction on a need-specific basis in order for beginner
Indian writers to become better communicators in American academia and industry.

The subsequent chapters in this document are organized as follows:

Chapter II includes a review of literature relevant to this research.

Chapter III describes the research design and methodology adopted for conducting this study.

Chapter IV reports and discusses the responses of Indian science writers interviewed in this study. It has been divided into four subsections. In the first subsection entitled “Cultural, Rhetorical and Writing Contrasts,” a synthesis of interview responses and pertinent literature review has been provided as a prelude towards understanding the cultural and educational system that most beginner Indian science writers are switching from. The three subsequent subsections “Rhetorical and Organizational Changes,” “Grammar, Language and Vocabulary-Related Concerns,” and “Identification of Some Typical Writing Strategies,” categorize typical writing problems that beginner Indian science writers face and the strategies that they adopt in an attempt to socialize themselves into western discourse communities.

Chapter V includes a conclusion and explores implications of the entire study.
CHAPTER II
REVIEW OF LITERATURE

To understand how Indian scientific writers are socialized into larger scientific discourse communities, it is necessary to understand how scientists function as part of a discourse community and how that broadly defines the way they use language.

PRODUCTION OF KNOWLEDGE

The goal of scientific research is to produce scientific knowledge that attains the "epistemological status of empirical truth," or in other words to make scientific claims that are "established beyond doubt" (Ziman 1984:35,48). Scientists write primarily to make such claims "public." Regardless of the merit of individual scientific research, a scientist’s claims and assertions are not judged "scientific" if they are not integrated with what others have already said on the subject and made easily available to the scientific community (Ziman 1984). Scientific communication is thus conducted within "homogeneous subgroups" with the primary purpose of gaining consensus (Gross 1984).

The concept of science as belonging to the domain of "public knowledge" or, to use Popper’s term, "world 3," makes academic science fundamentally social (Popper 1972). In fact, Ziman, in his Introduction to Science Studies (1984), defines academic science as a "social institution devoted to the construction of a rational consensus of opinion over the widest possible field" (10).

The success of a scientific explanation and prediction establishes the robustness of a hypothesis. The Popperian notion of "empirical falsifiability" thus becomes a fundamental characteristic of scientific hypotheses and theories, at least according to
followers of Popper. Since the scientific endeavor is "collective" and "communal," the "criteria of evaluation" and "standards of judgement" are located within the collective audience (Zappen 1983). Popper (1962) suggests that "the criterion of the scientific status of a theory is its falsifiability, or refutability, or testability." (37). He defines the "scientific method" as a series of "conjectures" and "refutations" through which scientific theories are held up for scrutiny for evaluation and judgement by the scientific community (Popper 1962). The continuous assessment and reassessment of scientific claims, conjectures, and hypotheses by peer groups of scientists leads to a changing/evolving consensus about what constitutes validated scientific knowledge (Ziman 1984).

Since scientific discoveries and theoretical explanations are prone to reevaluation, modification, and change in light of "new" findings, established knowledge can be replaced. "Under conditions of normal science," scientists work according to a set of common assumptions and beliefs called variously a "paradigm" or "disciplinary matrix" (Kuhn 1962, 1977). As research proceeds, "anomalies" occur that give rise to alternative theories, models and competing paradigms causing or culminating in a "paradigmatic shift" or "scientific revolution" (Kuhn 1962). When a set of such paradigms compete, only those that are most suited to the prevailing needs of the "thought collective" succeed in outliving the others (Toulmin 1972, Fleck 1979). The nature of knowledge-making in science is thus collective, communal, cumulative, and evolving (Ziman 1984; Zappen 1983).

Since the basic "social institution of science" is "its system of communication," the collective body of scientific knowledge is found in research articles, reports, theses...
and dissertations. A “primary scientific communication” is defined as an “original contribution to knowledge, by a named author or authors, normally published as a paper or article of limited length in a periodical or journal devoted to a specific scientific subject” (Ziman 1984:58).

SCIENCE AND LANGUAGE¹

Science uses language symbolically to describe the natural world through words and numbers. By depicting nature tangibly through symbols, scientists attempt to decipher, “predict,” and even control it. The symbols help us to envision reality as it exists (Bazerman 1988). The concept of a "pure philosophical language" that enables as close a match as possible between object and its symbol has been explored since the classical times (Bazerman 1988).

It is perhaps because of this great need to be exact and precise that analysis of scientific statements (as it exists today) reflects the use of a highly “specialized” kind of language that is not easily comprehensible to the uninitiated. The language of science is, for the most part, characterized by a profuse use of substantiation, figures, calculations and illustrations that enables scientific formulations to correspond to natural phenomena. And yet, in spite of the impressive reputation of scientific language for being objective, critics have been uneasy about its ability to represent natural phenomena in a dispassionate manner (Latour and Woolgar 1979).

¹ I am generally indebted to Shaping Written Knowledge (Bazerman 1988) for this analysis of the relationship between science and language.
In fact, many have begun to detect distinctly self-serving biases in scientific language. Among peer groups of scientists, scientific language helps to protect the interests of individual groups and research bodies, and at a larger level, it helps to entrench the authority of science through "exclusion and intimidation" (Knorr and Knorr 1978; Yearley 1981; Pickering 1984). "Scientific formulations," like any other formulations, are products of the human mind and as such are bound by certain imperfections. As Bazerman (1988) suggests, by "giving us no direct access to things in themselves," scientific formulations "seem to do all the social work of being human with no overt means of doing the empirical work," which has been considered the domain of science. The "appearance of reality," portrayed in scientific texts, he adds "is itself a social construction"(294-295).

Though linguistic theories in the present century have been largely silent on issues of how language represents the empirical world, there has been, of late, some interest in this area. Saussure's attempt to disassociate "langue" (linguistic code) from "parole" (contextualized use of language), and his highlighting of the "linguistic code" as the only appropriate area for research in linguistics has tended to give all such studies a "context-free code orientation." Previous studies of the use of language in science have thus been mostly focused on studying syntax and grammar, devoid of considerations in significance, context or function (Bazerman 1988). Because of the predominant tendency to study language synchronically, the study of the "historical evolution" of distinguishing features in scientific writing has been largely neglected. Thus, from the social relativist's point of view, the social use of language in scientific discourse has not yet been fully explored.
According to Bazerman (1988) there is a need for creating a single, unified language model or concept of "signifying events" that will take cognizance of "linguistic code," "social relations," "psychological cognition" and perception of the natural world -- all operating at the same time within the same context. Bazerman's interpretation and use of the model of language activity developed by Lev Vygotsky as a tool to analyze the social component in language use in scientific writing is instructive (Vygotsky 1987, Bazerman 1988). The Vygotskyan model allows us to see how in the business of articulating claims we bring into interplay various "cultural, social, psychological and material factors" to create and understand knowledge that is still "empirically conditioned" (Bazerman 1988: 295-296).

Vygotsky believed that language is a "problem-solving" tool that helps us to conduct mutually beneficial activities (Vygotsky 1978). To accomplish effective communication within a specific discourse group, the writer and reader must share a common understanding of language and technical expertise. Bazerman (1988) suggests that this very same concept of a communal background in terms of a collective knowledge of scientific and technical terms, and a "common membership" to the "conceptual and social worlds" is drawn upon in the compactness of a scientific article published in a journal. Internalizing these "interactional rules" that operate within a specific subgroup is thus an "important part of socialization into scientific activity" (303-304). By identifying these sets of collective ideals that define a group, we begin to comprehend the factors that compel scientists and researchers to use language the way they do. But more than that, these factors help us realize the dynamic interplay of forces
that transform essentially individual scientific "claims" into scientific facts that are accepted by the entire scientific community. Persuasion is the principal rhetorical skill that is employed to achieve such consensual objectives. According to Bazerman, skill in scientific writing depends on making "intelligent" rhetorical choices—the ability to understand and manipulate "symbolic actions" in order to achieve desired goals. As Ziman (1984) suggests, a scientific paper rarely reports a chronological account of daily activities in the laboratory or even a complete record of the basic "observational results"—it is fundamentally rhetorical. The rhetorical factor implicit in the production of scientific texts has been illustrated in making knowledge-claims (Myers 1990); in the "construction" of scientific facts (Latour and Woolgar 1979); and in transforming events it "supposedly" reports (Knorr-Cetina 1981). As Swales (1991) suggests in Genre Analysis, "it would be erroneous to assume that the writing of the RA [research article] is necessarily a straightforward task even for full and established members of the discourse communities" and that "it would appear that phenomena only acquire fact-like status by consensus and that consensus may not be achievable without rhetorical persuasion" (127).

**RHETORICAL ORGANIZATION: IMRAD**

The characteristic structural divisioning in scientific research writing is the four-part Introduction-Methodology-Results-Discussion (IMRAD) format. According to Hill, Soppelsa, and West (1982), however, the common rhetorical organization in all research papers such as dissertations, theses, or journal articles consists of three sections, depending upon their differing rhetorical functions within the research paper:
Introduction, Procedure, and Discussion. The Introduction section, according to them, "make[s] the transition from the general field or context of the experiment to the specific experiment by describing an inadequacy or inaccuracy in previous research which motivates the present experiment" (335). The Procedure, which consists of the Methods and the Results subsections, describes the methodology of data collection and the "manipulation" of the data gathered during the present experiment to enable replication by peer researchers. The Discussion, which is described as a "mirror-image" of the Introduction, extrapolates particular findings to broader implications (Hill et al. 1982). In many instances, however, the Results and Discussion sections may be combined or additional sections such as Conclusions, Implications / Applications may be incorporated into the text (Swales 1990). The rhetorical nature of the Introduction is illustrated by what Swales (1990) calls its "create a research space" purpose: establishing the significance of both the research field and the present research and showing how the edifice on which the research stands is to be supported. In other words, the Introduction consists of the justification of "claim" statements, "topic generalizations," a critical review of existing research in the field, identification of aberrations or "gaps," a statement of objective and an indication of primary results and overview of the text (Swales 1990). In view of the complex rhetorical roles that the Introduction fulfills, it is characterized by the use of rhetorical devices such as the heavy use of "that-nominals" (West 1980), reporting verbs such as "suggest," "report," "show," "establish" or "demonstrate" (Swales 1990), use of hedging words such as "however," use of modality words to indicate authorial stance such as "may," "should," adjectives and adverbs of
probability such as “possibly” or “certainly” (Adams Smith 1984), and “deictic elements” such as “this,” “the,” “present,” “here” or “now” (Swales 1990). The Methods and Results sections narrate the procedural activities and reporting of data. While the Methods section is marked by a heavy use of the past passive, the Results section is mostly in active voice (Swales 1990). The Methods section, as revealed by a survey of journal articles in botany, agriculture, and engineering, is also characterized by the use of cohesive devices and the use of “inferential bridging” where coherence is achieved by drawing on the readers’ specialized knowledge and expertise (Weissberg 1984). Since the mode of citation is simply to refer to a methodology by the name of the author, the progression of paragraph development in the Methods section appears not to be “linear,” thereby excluding non-specialist reading for a complete understanding of the text (Swales 1990). The Discussion section, which Swales (1990) describes as broadly “cyclic,” may consist of “references to previous research,” “explanation,” “exemplification,” “deduction and hypothesis,” and “recommendations.” In contrast to the Introduction, the Discussion comments on the general significance of present results by contextualizing specific results against existing knowledge (Swales 1990). By virtue of its rhetorical role of analyzing and explaining the results, the Discussion section makes several “claim statements” about the findings characterized by a heavy use of the that-nominal (West 1980).

The practice of incorporating citations, or referring to relevant literature within the text of the IMRAD format, fulfills several rhetorical purposes: illustrating that the author is thoroughly familiar with relevant research in that area, showing if the present work departs from or continues with established scientific traditions, and identifying
“gaps” or anomalies that it purports to address in existing research (Ziman 1984; Swales 1990). This element of “intertextuality,” or integrating of present work with the work of other researchers within the text, accounts for the “doubling” of the length of the scientific journal article in the past 40 years (Bazerman 1988; Swales 1990). Of late, the trend in academic research writing has been to focus on a cogent argument by situating research questions against a “rhetorically-established framework” of previously published literature and in the reporting and analysis of data (Swales 1990). In the review of literature, citational activities behoove the writer to indicate the name of the past researcher in two ways: “integral citations” where the name of the researcher(s) appears in the sentence proper, and “non-integral” citations where they appear in parentheses or superscript. The choice in the use of “reporting structures” in both integral and non-integral citational practices such as “demonstrate” or “show” over words such as “propose” or “examine” acts as a rhetorical indicator of whether the author considers such claims to be valid or not (Swales 1990).

DISCOURSE COMMUNITIES AND NONNATIVE SPEAKERS

It is useful to recollect at this point Swales’ (1990) notion of discourse communities that are identified as “sociorhetorical networks that form in order to work towards sets of common goals,” with a characteristic feature being that veteran members of such communities be familiar “with the particular genres that are used in the communicative furtherance of those sets of goals” (9). From a sociological standpoint, all writing activities within the academic research community can be viewed as a “social act” that derives meaning “within a specific context and audience; the “knowledge, the language
and the nature of discourse” being set by the discourse community for which it is
generated (Gosden, 1995:39). Universalists such as Widdowson (1979) claim that
“scientific exposition is structured according to certain patterns of rhetorical organization
which, with some tolerance for individual stylistic variation, imposes a conformity on
members of the scientific community no matter what language they use”(61). In spite of
the fairly uniform nature of scientific discourse that enables scientists from different
countries and with different linguistic backgrounds to communicate with each other in
recognizable ways, the social, cultural, historical, and educational differences across
nations and languages produce considerable “academic language variation.” Swales
(1990) draws attention to the “existence of two parallel discourse communities,” namely
one, a privileged group of western-trained scientists who participate in the research
community at the international level within a specific discipline, and two, a larger group
of native writers who are more susceptible and thus liable to be influenced by local,
traditional rhetoric. I would go a step further and suggest that such variations or
differences also exist in the context of nonnative scientific writing produced in academic
English. In other words, cultural, historical, and educational factors can explain
significant differences in certain discoursal features between academic writing in English
generated by nonnative writers trained in western countries and those produced by
nonnative writers trained entirely in their own countries.

The problem for novice nonnative writers hoping to become a part of their larger
scientific research communities is thus double-fold: one, as ESL writers coping with the
demands of a new genre and, two, as relative newcomers in their fields of academic
research (Gosden 1995). In order to gain "academic communicative competence," such writers need to become familiar with the shared goals and almost institutionalized conventions germane to specific discourse communities (Bazerman 1988; Johns 1990; Berkenkotter et al. 1991; Gosden 1995). The problems associated with the socialization of novice writers into highly specialized academic discourse communities in the university upon graduation from school is not restricted to just nonnative speakers—it is difficult for both native and nonnative speakers (Ballard 1984; Shaw 1991). Ballard's (1984) identification of some of these problems for beginner writers at The Australian National University (based on a pamphlet published for students) include: understanding that "each discipline has its own distinctive methods of analysis," learning to use appropriately the "highly specialized varieties of language" associated with such distinctive methodologies, understanding the differences between different "levels" of study within the same discipline, coping with the demands of critical evaluation, and learning to assess individual works. The socialization of nonnative writers into western discourse communities, however, oftentimes involves making an additional "double cultural shift" or crossing a "rhetorical gap" that enables them to produce texts acceptable to their academic peers in the international community (Ballard 1984; Swales 1990).

Previous research has indicated that such acculturation processes include, especially in cases of Asian writers, learning to develop a "voice" or a "point of view" in developing a critical synthesis or argument, removing "indirection" or the compelling urge to provide background material before getting to the point, and moving away from the "reproductive" mode of knowledge-acquisition fostered by a predominantly
authoritarian instructional mode in their native countries (Fox 1994; Tucker 1995; Ballard 1984). These researchers also claim that in the cases of Asian nonnative writers, initial difficulties in generating texts in a manner that conforms to the demands of specific discourse communities in western countries by nonnative speakers can be traced back, in part, to "linguistic incompetence," but also to "cultural dislocation" prompted by "passive classroom behavior," reliance on textbooks, and "rote learning" acquired in their home countries (Ballard 1984). St. John's (1987) study of Spanish writers, Ventola's (1992) study of Finnish science writers, and Sionis' (1995) study of French writers indicate such problems as unfamiliarity with the written requirements of the genre of specialized science article, inability to argue, language deficiencies and cultural rhetorical differences can also arise in non-Asian western nonnative contexts. Although researchers have used the term "Asian" generically in most cases, they have done little to define specific characteristics of Indian science writers.

ENGLISH FOR SCIENCE AND TECHNOLOGY (EST) AND NONNATIVE SPEAKERS

The category of English used in scientific contexts is usually referred to as English for Science and Technology (EST) (Trimble 1985). Through EST, scientists and students of science from different linguistic and sociocultural backgrounds explore, discover and evaluate scientific truths. To gain international readership and, thus, participate in what Latour and Woolgar (1979) call "cycles of credit," most scientists in the non-English speaking world prefer to publish in English rather than in their native language.
The acquisition of English as the language for scientific discourse has often proved difficult for the nonnative scientist. Although a significant proportion of the research articles in science and technology is published in English, the nonnative contribution is considered "low" (Swales 1985). A significant part of the larger process of being socialized into the scientific discourse community that the nonnative writers in English-speaking environments wish to belong to involves learning to write in English (Shaw 1991).

The literature on international scientific writing suggests that although there has been some interest in the area in the last decade or so, not much research has been done towards documenting the writing strategies (in a broad sense), of foreign-born science writers in this country. However, a review of the extant literature on nonnative science writing suggests that nonnative writers face a variety of writing problems. A study conducted with 17 nonnative dissertation writers in Newcastle University, UK found that most reported having problems with determining appropriate audience and vocabulary (Shaw 1991). The appropriate use of hedging devices while substantiating claims is construed as being more difficult by nonnative speakers (Parkhurst 1990). Nonnative speakers also have been found to indulge in meticulous planning and often write bilingual drafts (St. John 1987; Parkhurst 1990). It is also not uncommon to find writers adopting a "jigsaw" approach where useful expressions from published literature are "lifted" and incorporated into the text (St. John 1987; Shaw 1991).

St. John's (1987) study on the writing strategies of proficient Spanish science writers reports negative reception of critical feedback. Proficient nonnative science
writers appear to make most of their revisions at the sentence-level (vocabulary and grammar), and seem to ignore suggested changes made at the rhetorical/discourse-level (St. John 1987). Parkhurst’s (1990) separate study on the writing of a mixed group of native and nonnative science writers, while corroborating the same idea, suggests that overall, nonnative speakers tend to get less feedback than their native counterparts.

Most nonnative speakers express difficulty in writing the Introduction and Discussion sections because of a lack of complex rhetorical skills required to justify choice of research topics (Shaw 1991; St. John 1987). Conversely, the Methods and Results sections were considered “easy” because they involved “straight factual descriptions” (St. John 1987). In a Stanford-based study of the attitudes and perceptions of graduate faculty in arts, sciences and social sciences regarding the writing requirements of their doctoral candidates, discourse-level competence was rated higher than sentence-level proficiency (Casanave and Hubbard 1992). However, in a study conducted with the faculty of six engineering schools relating to the writing requirements of their graduate students, while 36% of 176 suggested that they used different criteria for evaluating the writing of their nonnative students, most usually at the sentence-level, 21% made allowances for evaluating writing of these students at the discourse-level (Jenkins et al. 1993). This impression is corroborated by Casanave and Hubbard (1992) who found that while both native and nonnative speakers have problems with writing, nonnative speakers tend to have more problems than their native counterparts at the sentence-level. Interestingly, there was little difference in discourse-level competence between native and nonnative speakers (Casanave and Hubbard 1992).
In the case study of a Brazilian student writing a thesis in the UK, writing over-long sentences, faulty referencing, inadequate use of cohesive devices, and lexical difficulties were identified as some of the common problems (James 1984). To determine the communication strategies adopted by two groups of French researchers based on a comparative study of research articles written for submission to anglophone journals, Sionis (1995) found that linguistic inadequacies led them to use “message reduction” strategies such as an over-reliance on mathematical language, charts and figures, eschewing relevant steps in clarification leading to ambivalent construction of texts, and an under-use of argumentative devices. Ventola’s (1992) study of 31 drafts written by Finnish researchers for submission to anglophone journals also identifies problems in thematic development, textual cohesion and referential patterns arising out of cultural, educational and rhetorical differences.

SUMMARY

The socialization of novice writers into academic scientific discourse communities is difficult and is doubly so for nonnative speakers. A review of these studies indicates that while nonnative speakers indulged in more “mental planning,” they had more difficulty in moving from a spoken to a written register, received less or dealt poorly with feedback, and, in general, had more local language problems. In some other cases such as in discourse-level competence, they were considered equal. Problems in structure, organization, and use of appropriate argumentative devices in nonnative writing cannot be wholly explained, however, by linguistic inadequacies; they arise, as some researchers point out, from “cultural dislocation.” While these studies provide valuable insights, more
research in the area of novice nonnative writing is needed as it is relatively understudied (Swales 1990; Casanave and Hubbard 1992). The writing of Indian science writers, in this context, has been largely ignored. The present research by documenting the socialization process of Indian science writers into western discourse communities begins to address such a need.
CHAPTER III

METHODOLOGY

While in the preceding two chapters the theoretical premises of the present work were laid out, in this chapter I will explain how data were collected, classified and analyzed in order to understand ways Indian science writers socialize themselves into western discourse communities.

COLLECTION OF DATA

Interviews and Drafts

To understand how Indian scientific writers learn to follow the writing conventions of their particular US scientific communities, I conducted interviews and studied rough drafts of articles and dissertations. The purpose was to gain qualitative information through a five-page questionnaire. Twenty-eight Indian science writers and five native-speaking faculty members were interviewed for this study. To facilitate the information-gathering process, respondents were classified into three groups according to places of training and writing skills (please see subsequent section for details on groupings).

Although the basic format of the questionnaire remained intact for the first three groups in my study (inasmuch that it focused on identifying specific writing problems and how they were overcome), slight modifications were made for each of these groups to suit their appropriate socio-cultural and rhetorical situations. The slight differences in the questionnaires pertain to eliciting information on the differences in the varying needs and requirements of academic writing between India and the USA for a better understanding of the socialization process of beginner Indian science writers (please see Appendix A for
the questionnaires). A fourth group consisting of native-speaking faculty members was provided with a separate questionnaire. The questionnaire(s) formed the basis of my interviews: the interviewees responded as I asked them questions in the order that they are listed in the questionnaire(s). Single interviews lasted from 90 to 120 minutes; and typically, I had two to three sessions (i.e. interviews) with each of my subjects. Since most of the interview questions had been designed to elicit somewhat detailed explanations, I recorded as faithfully as possible their responses to the questionnaires by taking handwritten notes. The interviews also consisted, in some cases, of clarifications of textual revisions made in successive drafts of dissertations/articles for submission. My procedures were based on those in previous studies on the composing processes of science writers, most notably Parkhurst (1990) and Shaw (1991). Though Shaw’s study focuses only on thesis-writing by nonnative speakers from different countries at the University of Newcastle-Upon-Tyne, UK, I have found it useful to adapt a few of his questioning strategies in the questionnaire(s) for the first three groups in this study. Although Jenkins et al. (1993) do not use the interview for their survey of faculty impressions on student writing, I have also adapted a few questions from their questionnaire in the questionnaire for the fourth group consisting of native-speaking faculty in this study.

The interview strategy was appropriate for my study because it provided an opportunity to probe or redefine questions for a better generation of accurate information on a one-to-one basis. Referring to Braine (1989), Jenkins et al. warn against “imposing predetermined definitions of writing tasks on other disciplines” (Jenkins et al.
1993:53). It was also advantageous because in certain cases, it allowed for bilingual communication when the respondents felt the need to use their native languages. For instance, for a few of the beginner-dissertation writers with whom I shared a common mother tongue, I was able to translate terms and concepts related to the questionnaire in their native language.

Depending on the availability of drafts, I chose a core group consisting of three to five respondents from each group. The rough drafts of dissertations/scientific articles produced by such a group were analyzed to study the frequency and nature of revisions that writers are apt to make. The comments of advisors in cases of dissertation writers and review comments in cases of writers of research articles have been noted at appropriate places in Chapter IV. Information gathered from such sources has been used as corroboratory material to supplement information obtained through the interviews. Although I attempted to obtain written drafts in a uniform manner, this was not always possible for practical reasons. While some dissertation writers, who are still in the process of writing, could not provide me with drafts for all their chapters, others provided consecutive drafts of certain chapters excluding the final version. In cases of scientific articles, marked copies sent by reviewers were not always available. This was primarily so in cases of the Old and New Immigrants (Group II) writers, who due to word-processing capabilities made revisions directly on the computer. In most cases, the revised drafts were not final versions but merely constituted visible records in the intermediary stages of writing that was continually evolving. However, every effort was made to reconstruct the general trends in the revisions that the writers made between the successive stages.
Groupings

I interviewed four groups of scientific writers. All the science writers who were identified as respondents for this study were conducting research in fields generally related to engineering and basic sciences. (Please see "Identification" and "Description" of respondents in the following sections.) This study includes a wide variety of Indian science writers ranging from very successful writers who edited American and British academic journals, to novice writers such as graduate students who were on the thresholds of entering their respective discourse communities. The classification of groups and the appropriate number of respondents in each group are shown below:

Table III.1. Classification of Writers into Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Name</th>
<th>Description</th>
<th>Number of Interviewees</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Indigenous Writers</td>
<td>Indian scientists (faculty members) and Indian graduate students who were trained in India and have worked entirely in India.</td>
<td>8</td>
</tr>
<tr>
<td>II</td>
<td>Old and New Immigrants</td>
<td>Indian scientists (faculty members) and graduate students who were initially trained in India, but subsequently continued their careers in the USA</td>
<td>13</td>
</tr>
<tr>
<td>III</td>
<td>Foreign-Returned</td>
<td>Indian scientists who were initially trained in India, received further training in the USA, and subsequently returned to India as working scientists or as members of professorial faculties.</td>
<td>7</td>
</tr>
<tr>
<td>IV</td>
<td>Native-Speaking Faculty</td>
<td>Members of the professorial faculties (native speakers of English), who direct the writings of Indian graduate students in science and engineering schools in the USA</td>
<td>5</td>
</tr>
</tbody>
</table>
Group II is envisaged as the primary source of information since it describes most fully the continuous and evolving process of socializing Indian science writers into the western scientific community. While the focus of the study is Group II, the purpose for the classification into four groups is to use the other groups as sources of supplemental knowledge that would generate a wider cross-section of responses to my queries. For instance, while Indigenous Writers (Group I) respondents generate information only in the Indian context, respondents from Groups II and III comment on the Indian context as members of western scientific discourse communities. Again, while members of Group IV generate information on the writing practices of Indian science students in the USA, Group III are able to do the same—but from a different perspective because of their own writing experiences in India.

A further rationale behind the classification is that since preliminary talks with the respondents during my first trip to India indicated that notions about writing (scientific writing, in particular) undergo considerable perceptual changes once the writers are exposed to western discourse communities in American universities, it would be useful to classify the writers according to their places of training and discourse skills. At the risk of making some generalizations (since individual writing skills tend to vary), I have assumed for the purposes of this study that along a continuum within the first two groups, all faculty members to be skilled writers or socialized writers and all dissertation writers to be beginner or novice writers, who were yet to be socialized. Since the status of a “skilled writer” has been equated with a researcher who can illustrate “competence” in “anglophone [dominated] discourse communities” (Swales 1990:10-11), mostly through
“successful publications” (Gosden 1995), all Indian faculty members who were interviewed for this study can be called such due to their impressive publication records (ranging from 18 to 200 published articles in refereed journals). Group IV is the only group that consists entirely of native-speaking faculty members. Though the focus of this study is not on native English speakers, their inclusion enables me to study how the perceptions of skilled native English writers on Indian scientific writing match with those of the Indian science writers themselves.

Since these groups will be referred to quite frequently in the following chapters, I have named them to facilitate the reader’s point of reference for a better understanding of the differences amongst Indian science writers, both in terms of their places of training and writing skills (please see Table III.1). Accordingly, Group I members, consisting of Indian faculty and graduate students who have remained entirely in India, are called “Indigenous Writers.” Group II, consisting of Indian faculty members who were trained in the USA/UK and have continued their careers in the USA and Indian graduate students who were in the process of writing theses/dissertations or have just completed writing them, is called “Old and New Immigrants.” While “Old” denotes Indian faculty members, “New” refers to the Indian graduate students. Group III, consisting of Indian faculty members who gained their higher education in the USA/UK and have returned to India to pursue their academic careers, is called “Foreign-returned.” Group IV, consisting of native-speaking faculty members at Louisiana State University, is called “Native-Speaking Faculty.”
Identification of Respondents

The nature of this research is such that I thought it more fruitful if I identified respondents who agreed to rather lengthy interviews and were in a position to provide drafts for analysis from the beginning. Since almost all the respondents in Old and New Immigrants (Group II) were based at Louisiana State University, respondents were identified through the Campus Staff and Student Directory, 1995, according to their names, departments and linguistic backgrounds. Initial contact was established by telephone, and those who agreed to the interview were included in the study. This eliminated the need to mail time-consuming survey documents, which, as some research shows, can be vulnerable to being inadequately responded to or not responded to at all (Jenkins 1993; Casanave and Hubbard 1992). The number of respondents in each group thus merely indicates the number of people who agreed to participate in the interview. Since the questionnaire involved rather detailed responses, it was not mailed to the respondents but rather formed the basis of interview-discussions. Old and New Immigrants (Group II) consisted of seven faculty members from disciplines such as Civil Engineering, Electrical Engineering, Mechanical Engineering, and Chemical Engineering and six doctoral students who are writing, or have just finished writing, their dissertations in Industrial Engineering, Microbiology, Physics, Civil Engineering, and Computer Science.

Two research trips were made to Calcutta, India (Winter of 1995 and Summer of 1996) to locate, identify, and interview respondents for Indigenous Writers (Group I) and Foreign-Returned (Group III). I located respondents in Calcutta in some cases by introducing myself to faculty members in science and engineering departments and
identified respondents from among those who agreed to the interviews. In some other cases, I identified respondents from referrals provided to me by an Indian faculty member at LSU and mutual acquaintances in Calcutta. The respondents for these groups included doctoral students and faculty members (those who agreed to interviews) from University College of Science, Calcutta University, Calcutta; Jadavpur University, Calcutta; Indian Statistical Institute, Calcutta; and Bose Institute, Calcutta. The Indigenous Writers (Group I) consisted of three young faculty members from Chemical Engineering, Mechanical Engineering and Geology; and five doctoral students in various stages of writing their dissertations in Statistics, Computer Engineering, Zoology, and Microbiology. Foreign-Returned (Group III) consisted of seven tenured faculty members from Geology, Physics, Applied Chemistry, Statistics, Biochemistry, and Computer Engineering in research institutions in Calcutta. The five respondents in Native-Speaking Writers (Group IV) were identified from among disciplines that have large numbers of Indian graduate students at Louisiana State University, namely Computer Science, Mechanical Engineering and Electrical Engineering.

**Linguistic Background of Respondents**

The Constitution of India recognizes 14 official languages. In addition to these, 10 other languages and several other dialects are spoken by “over a million or more persons each” (World Factbook 1997: 2). Indian science writers in American universities thus come from many different native-language backgrounds. This study is not restricted to a specific linguistic group within the Indian context, nor is it devoted to studying particular native “language interferences” (Swales 1990) in the production of text in the English
language within a specific linguistic group. Respondents from the first three groups include writers from a variety of Indian language groups: Bengali, Oriya, Hindi, Marathi, Telegu, Kannada, Malayalam, Marwari, and Gujarati. Since all respondents had English as their medium of instruction at school and collegiate levels and, moreover, had passed standardized English Language proficiency tests in India and the USA, a certain base level of proficiency in English for all respondents is assumed for the purposes of this study.

Table III.2 summarizes the total number of respondents as graduate students and faculty from basic sciences and engineering.

<table>
<thead>
<tr>
<th>Group</th>
<th>Engineering</th>
<th>Basic Sciences</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Graduate</td>
<td>Faculty</td>
<td>Graduate</td>
</tr>
<tr>
<td>I</td>
<td>0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>II</td>
<td>1</td>
<td>7</td>
<td>5</td>
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<tr>
<td>III</td>
<td>x</td>
<td>1</td>
<td>x</td>
</tr>
<tr>
<td>IV</td>
<td>x</td>
<td>3</td>
<td>x</td>
</tr>
</tbody>
</table>

x = Not applicable in these groups.

**Description of Respondents**

**Indigenous Writers (Group I)**

The writers in this group have to date written entirely within the confines of the Indian academic environment and have participated only indirectly with western discourse communities in occasional attempts to publish in international journals; they, therefore, provide excellent opportunities to understand the indigenous "writing situation" in India. If we are to understand how writers from India socialize themselves into western
discourse communities, it is of some significance to consider their writing activities in the preliminary stages.

Group I constitutes eight members of the Indian science writing community who have been trained in India and have worked entirely in India. Of the eight respondents, five are graduate students (three males and two females) in various stages of writing their dissertations, and three are young faculty members (all males) with doctoral degrees. While three of the dissertation writers belong to the basic sciences, two are working in areas of overlap with engineering sciences. Two of the faculty members belong to engineering sciences, with the third being in basic sciences. All members of this group, with the exception of one graduate student, acquired their high school education in their native languages. All respondents, however, received their higher education in English. The five graduate students in this group write certain additional "routine" documents during the dissertation-writing process, including annual reports or progress reports on their major projects. All of them are also in various stages of drafting journal articles for publication in Indian or international scientific journals. Two graduate students have published at least two articles each in international journals in their specific disciplines. The three faculty members, on the other hand, routinely write proposals and status reports. All three have published extensively, ranging from 18 to 39 articles in Indian or international journals. (Please see appendices C and E for other details.)

Old and New Immigrants (Group II)

In some ways, this is a pivotal group since it includes eight writers who, though at different levels, are all in the process of socializing themselves into their respective US
discourse communities. The remaining five, who are extremely skilled writers with an average of over 75 published articles to their credit, have been socialized. Cumulatively, they provide useful insight into how writers learn to write according to the demands of their academic communities.

Old and New Immigrants constitutes 13 members of the Indian scientific writing community in science and engineering who, after gaining part of their higher education in India, are continuing their careers in the USA, more specifically at Louisiana State University (except one). Of the six graduate students (three males and three females) in this group, five are in basic sciences and one in engineering. Three who began as graduate students for this study have just finished their dissertations and assumed postdoctoral positions elsewhere in the country. One also finished her dissertation at Rice University, Houston. The other three graduate students are in the process of writing their dissertations. The other seven members of this group are faculty members (all males) in science and engineering. Five have acquired their doctoral degrees from other universities in the USA and have continued their teaching and research careers at Louisiana State University for the last several years. Of the remaining two, one is working as a research associate and the other as an instructor on campus. Of the 13 members in this group, seven acquired their high school instruction in their native languages and subsequently switched to English at the collegiate level. The rest have always had English as their medium of instruction. While the graduate students write project reports and "problem-solution" analytical assignments while pursuing their careers, the faculty members in this group write journal articles, books, review articles, proposals, and technical reports.
an average, these faculty members produce a substantial number of published material—ranging from 75 to 150 research articles in American and European journals. The beginner writers in this group, i.e., the graduate students who are pursuing their doctoral degrees, on the other hand, have one to two published writings. The two members (research associate and instructor) who fall somewhere in the middle have three to eight published articles. (Please see appendices C and E for other details.)

**Foreign-Returned (Group III)**

Although a supplemental group in nature, the members of this group are important sources of information in outlining the socialization processes that enable them to function as effective members of western discourse communities. They are in some ways unique because of the double perspective they can bring to this research. On the one hand, they act as socialized members because of their partial stays in the USA or other European countries as faculty members or research associates and as a continuation of such research and publication activities from their present positions as faculty members in India, on the other. Having participated fully in western discourse communities by publishing numerous scientific articles in western academic journals, they are also in a position to pinpoint the writing obstacles that their Indian graduate students in India may or may not face in their attempts to socialize themselves into western discourse communities. Group III constitutes seven members of the Indian science writing community who are all faculty members (all males) in universities and research institutes in India. Of the seven respondents in this group, six are in basic sciences and one in engineering. Group III differs from Indigenous Writers (Group I) in that it includes no
graduate students and its members conducted part of their higher education and research in foreign universities in the USA, UK, or Europe. The members of this group differ from Old and New Immigrants (Group II) in that they include no graduate students, and unlike the faculty members in Old and New Immigrants (Group II) members, have returned to India to continue their research activities and direct the work of graduate students. All members of this group received their high school instruction in their native languages, but switched to English at the college-level. The science writers in this group participated as part of the western discourse community either as dissertation-writers or postdoctoral researchers. Two of the respondents obtained their doctoral degrees in USA, one each in Sweden and the UK, and the remaining three worked as postdoctoral researchers in the USA. Like the Indian faculty members in Indigenous Writers (Group I), respondents in this group too routinely write proposals, scientific journal articles, and review articles. All members of this group write extensively, with the number of published articles in mostly international journals ranging from 40 to 200 papers. Two of these respondents have written single-authored books, while a third wrote two single-authored books and one that was co-authored.

**Native-Speaking Writers (Group IV)**

Five native speaking faculty members (one female and four males) from the Science and Engineering colleges at Louisiana State University were interviewed to gain their impressions about the writing of their Indian graduate students. All of these faculty members belong to departments that tend to have a large number of Indian graduate students. Two of these are from Computer Science, two from Mechanical Engineering
and one from Civil Engineering. (Please see Appendix C for additional information on respondents.)

ANALYSIS AND INTERPRETATION OF DATA

Keeping in mind the differences between India and the USA in writing conventions and the academic environments that help define them, I will analyze information generated from the interviews and study of drafts according to the following major subdivisions in the “Responses to Interviews and Interpretation of Responses” (Chapter IV). The subdivisions are based on summaries of responses to relevant sections in the questionnaires.

- Cultural, Rhetorical and Writing Contrasts
- Rhetorical and Organizational Changes
- Grammar, Language and Vocabulary-Related Concerns
- Identification of Some Typical Writing Strategies

Cultural, Rhetorical and Writing Contrasts summarizes the responses of Indian science writers interviewed for this study to the section entitled “Cultural, Rhetorical and Writing Contrasts” in the questionnaire(s). Since the Native-Speaking Faculty (Group IV) is largely supplemental, their responses were integrated in the analysis at appropriate points in the text. It was felt that for a more complete understanding of the socialization process of Indian science writers into western discourse communities, it would be necessary and useful to review the expectations, needs, and requirements of academic writing in the English language that exist in India. This subsection, which summarizes interview responses on such perceived cultural and rhetorical differences and related
literature review, is devised as a "background" that will provide an appropriate contextual framework for a better understanding of the more specific writing problems that beginner Indian science writers tend to face in western universities, detailed in the succeeding sections. Information gathered in this section will be described under the following subheadings:

- The Academic System in India and Its Impact on Writing
- Publication Culture in India
- Changing Perceptions About Writing Among Indian Scientists
- Summary: Suggestions to Improve Science Writing Skills in Indian Education

Rhetorical and Organizational Changes summarizes the responses of all Indian science writers interviewed for this study to the section entitled "Organization and Rhetorical Structure" in the questionnaire(s), and the analyses of the revisions made in drafts. This section is divided into two broad subsections: Summary of Responses and Interpretation of Responses. While the Summary subsection will document or report information gathered from the interviews and drafts, the Interpretation will analyze the implications of the results found against existing knowledge. The comments of Native-Speaking Faculty (Group IV) have been integrated at appropriate places in the Interpretation section.

The preceding chapters indicated that good scientific writing is significantly rhetorical (Ziman 1984). The formal structuring of scientific texts in theses, dissertations, and journal articles according to the IMRAD format and use of what Ziman calls the "formal linking mechanism" (60) by citation fulfill certain important rhetorical roles (Hill
et al. 1982; Bazerman 1988; Swales 1991). Within the text, these are demonstrated (especially, in the Introduction and Discussion sections) in the skillful establishing of "need" or research topic, justification of claim or evidence, and illustration of continuity with or departures from previous work in research methodology. Information gathered primarily from the interviews on how different groups of writers cope with the rhetorical demands of the IMRAD format will be arranged under the three different groups of Indian science writers according to the following subheadings: IMRAD Organization and Citation. Since the purpose of the investigation is to study how writers are socialized into western discourse communities, the focus of analysis and discussion is to study the problems that beginner writers tend to face within and outside India, and how once they are exposed to western discourse communities, writing objectives and strategies undergo changes across and within the three different groups of Indian science writers identified for this study.

Changes can be measured in part by studying textual modifications or revisions. Knorr-Cetina (1981), in her analysis of writing behaviors of a group of biochemists, reported three main methods for textual revisions. These included "deletion" of statements containing scientific information or textual deletions, "reshuffling" of sentences, and "modality" changes relating to textual revisions while making assertions and claims. Gosden (1995), in his study (based on a systemic-functional-linguistic framework of textual analysis) of successive drafts produced by Japanese doctoral students in engineering, included a fourth category called "addition" of statements containing scientific information or textual additions. Borrowing from Swales (1990),
Gosden modifies modality changes to include a component of "rhetorical machining."

Rhetorical machining, according to Gosden, deals with appropriate rhetorical word-choices in discourses of statements of purposes and claims. While both these studies involve a much smaller number of respondents and focus specifically on successive drafts written by the same people, this current study has a much wider scope, attempting to identify broadly the changes in writing practices of a socio-cultural group across two distinctly different academic environments. Although a systemic-functional-linguistic framework of textual analysis is beyond the scope of the present work, I have adapted some features of the Knorr-Cetina-Gosden classification system of textual modifications for this study. I will borrow certain terms such as "textual deletions," "textual additions," "reshuffling of sentences" and "modality changes" to study the differences in number and kind in textual revisions made by skilled and unskilled writers across the three different groups of Indian science writers. Do beginner writers in Indigenous Writers (Group I) members make more textual deletions/additions/reshuffling of sentences in the Introduction and Discussion sections (traditionally believed to be the most difficult to write for nonnative speakers) than the beginner writers in Old and New Immigrants (Group II)? Since drafts are rather tangible forms of documenting the "interactional" processes between beginner writers and other discourse community members, advisorial comments, informal peer review comments and formal review comments were noted, if any. Three to five sets of drafts from each of the three groups of Indian science writers were studied to gain supplementary information to corroborate primary information obtained through interviews. Passages showing evidence of extensive revisions were
selected. Information gathered was classified under Textual Revisions according to the following four subcategories:

- Textual Additions
- Textual Deletions
- Reshuffling of Sentences
- Modality Changes (Instances where writers are revising statements regarding purposes and on the "levels" of claims made as attempts in "rhetorical machining.")

The implications of such changes will be discussed and incorporated at appropriate points in the Interpretation subsection for this section.

Grammar, Language and Vocabulary-Related Concerns summarizes the responses of all Indian science writers in the first three groups to the section entitled "Language Concerns" in the questionnaire(s). As in the previous section, this section consists of two broad subsections: Summary of Responses and Interpretation of Responses. While the Summary section reports information gathered during this research, the Interpretation analyzes the implications of the findings against existing research. It may be recalled from the literature review described in Chapter II that nonnative writers are generally reported to have more "surface-level" writing problems, such as grammar and vocabulary, than native speakers (Shaw 1991, Casanave and Hubbard 1992). Nonnative writers are also believed to reveal more concern about grammar, using correct and precise expressions, vocabulary and word-choice (St. John 1987, Parkhurst 1990). Information gathered from the interviews is presented and analyzed under the three different groups of Indian science writers according to two
subheadings: Grammar and Language and Vocabulary. In a study of revised drafts written by Finnish researchers, Ventola (1992) reports heavy nominalizations, ineffective use of cohesive reference chains (such as the use of "a," "an," "some," "the" or "they") and absence of the use of the article system as some of the writing problems common to Finnish writers.

Although a textlinguistic study similar to Ventola's is beyond the scope of the present study, a core set of three to four sets of drafts is reviewed to identify certain illustrative examples whereby Indian science writers across the three groups had made revisions in singular/plural, tenses, heavy nominalizations, sentence structure and vocabulary. These are incorporated and referred to in the Interpretation subsection under the appropriate subheadings. The comments of the Native-Speaking Faculty (Group IV) are incorporated at appropriate points in the Interpretation subsection.

Identification of Some Typical Writing Strategies summarizes the responses of all Indian science writers interviewed for this study to the sections entitled "Writing Activities" and "Writing Influences: Sources and Feedback" in the questionnaire(s). As in the previous two subsections, this section consists of two broad subsections: Summary of Responses and Interpretation of Responses. The literature review suggests that nonnative writers indulge in extensive planning and outlining before commencing to write (St. John 1987; Parkhurst 1990; Shaw 1991). Other writing strategies noted previously include writing bilingual drafts (Shaw 1991; Sionis 1995), "lifting" useful terms and phrases from published literature (Shaw 1991; St. John 1987), and striving to write with clarity (Parkhurst 1990). Sionis (1995), in his study of the communication strategies adopted by
two groups of French researchers, reports "Message Adjustment" and "Resource Expansion" strategies that nonnative writers adopt in order to compensate for inadequate command over the English language. While the former includes strategies such as "Topic Avoidance" (missing step and ambiguous construction), "Semantic Avoidance" (ambiguous construction) and "Message Reduction" (incomplete information due to excessive reduction and simplification of messages), the latter includes strategies such as the excessive use of mathematical language, charts, and figures.

Since knowledge-making in science is communal and consensual, informal peer critiquing among immediate colleagues is construed as an important socializing factor for beginner writers. A category in this section is devoted to noting the nature and sources of feedback from which Indian science writers benefit. Information gathered is presented under the three different groups in the Summary of Responses subsection according to the following categories:

- Planning, Writing, and Revising
- Language of Thought
- Peer Review and Feedback
- Use of Reference Material.

In the Interpretation subsection, where the implications of the findings of this research are viewed against existing research across the three different groups of Indian science writers, the categories include:

- Planning
- Language of Thought
• Sionis' "Message Adjustment Strategies"
• Sionis' "Resource Expansion Strategies"
• Peer Review and Feedback
• Reading and Using Reference Material.

The comments of the Native-Speaking Faculty (Group IV) will be incorporated at appropriate points in the Interpretation subsection.

Since the overall purpose of this study is to explore how Indian scientific writers are socialized into western scientific discourse communities and, to a further extent, to study how they perceive of the changes in their writing approaches to accomplish it, the responses of such a wide variety of subjects under review will enable me to arrive at some conclusions about how Indian scientific writers learn to write a dissertation/article in the USA. For an overview of the divisions in the "Responses to Interviews and Interpretation of Responses" chapter, please see Figure III.3.
Table III.3. Overview of “Responses to Interviews and Interpretation of Responses,” Chapter IV

<table>
<thead>
<tr>
<th>Cultural and Rhetorical Writing Contrasts</th>
<th>Rhetorical and Organizational Changes</th>
<th>Grammar, Language, and Vocabulary-Related Concerns</th>
<th>Identification of Typical Writing Strategies</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Academic System In India and Its Impact on Writing</td>
<td>Summary of Responses</td>
<td>Summary of Responses</td>
<td>Summary of Responses</td>
<td>Cultural, Rhetorical and Writing Contrasts</td>
</tr>
<tr>
<td>Writing Instruction and Status of English in India</td>
<td>Indigenous Writers</td>
<td>Indigenous Writers</td>
<td>Indigenous Writers</td>
<td>Rhetorical and Organizational Changes</td>
</tr>
<tr>
<td>Recent Changes in English Writing Instruction in India</td>
<td>IMRAD Organization</td>
<td>Grammar and Language</td>
<td>Planning, Writing, and Revising</td>
<td>Grammar, Language, and Vocabulary-Related Concerns</td>
</tr>
<tr>
<td>Reproductive Learning. Lack of Focus on Critical Skills</td>
<td>Citation</td>
<td>Grammar and Language</td>
<td>Language of Thought</td>
<td>Identification of Typical Writing Strategies</td>
</tr>
<tr>
<td>Other Factors: Lack of Resource and Motivation, Stagnation</td>
<td>Textual Revisions</td>
<td>Vocabulary</td>
<td>Peer Review and Feedback</td>
<td></td>
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<tr>
<td>Publication Culture in India</td>
<td>Old and New Immigrants</td>
<td>Old and New Immigrants</td>
<td>Use of Reference Material</td>
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<tr>
<td>Changing Perceptions About Writing</td>
<td>IMRAD Organization</td>
<td>Grammar and Language</td>
<td>Foreign-Returned</td>
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<td>Citation</td>
<td>Vocabulary</td>
<td>Grammar and Language</td>
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<td>Textual Revisions</td>
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<td>Foreign-Returned</td>
<td>Textual Revisions</td>
<td>Textual Revisions</td>
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<tr>
<td>Summary: Suggestions to Improve Science Writing Skills in Indian Education</td>
<td>Interpretation of Responses</td>
<td>Interpretation of Responses</td>
<td>Planning, Writing, and Revising</td>
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<td>IMRAD Organization</td>
<td>Grammar and Language</td>
<td>Language of Thought</td>
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<td>Citations</td>
<td>Vocabulary</td>
<td>Peer Review and Feedback</td>
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<td>Language of Thought</td>
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<td>Sionis’ “Message Adjustment Strategies”</td>
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<td>Sionis’ “Resource Expansion Strategies”</td>
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<td>Peer Review and Feedback</td>
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<td></td>
<td>Reading and Using Reference Material</td>
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CHAPTER IV
RESPONSES TO INTERVIEWS AND INTERPRETATION OF RESPONSES
CULTURAL, RHETORICAL AND WRITING CONTRASTS

This section will summarize and analyze the responses of Indian science writers included in this study to the questionnaire section entitled “Cultural, Rhetorical and Writing Contrasts.” However, to better understand the broader causes of writing challenges faced by Indian science writers when they move into western discourse communities, it is first necessary to gain some insight into the Indian writing environment from which they are switching. Accordingly, this section will begin by describing the academic system prevalent in India and its impact on writing skills and outlining the differences between writing in India and the USA or any other western country as perceived in published literature and by the writers themselves. This description, in turn, will help explain both the transitional efforts that these writers engage in to be accepted by their academic communities and how their efforts differ in origin from other novice writers, despite many apparent similarities. Most important for this dissertation, attempts will also be made to determine writing problems specific to Indian science writers and to make suggestions for curricular changes to overcome them.

In brief, my research indicates that the text-based authoritarian instruction system in India encourages reproductive learning and ignores the development of critical and rhetorical skills in students. Variable language policies and schooling systems produce students with varying language proficiency skills. A combination of such factors and
cultural traits such as providing background contextual information, a lack of incentives for publication and scientific writing instruction ill prepare the average beginner science writer to cope with the demands of western scientific discourse.

Unlike in the other sections in Chapter IV, the responses to the questionnaire will not be organized according to specific groups but will be grouped under the following categories:

- The Academic System in India and Its Impact on Writing
- Publication Culture in India
- Changes in Perceptions about Writing
- Publication Culture in India
- Summary: Suggestions to Improve Science Writing Skills in Indian Education

Comments of the native faculty members in science and engineering at LSU and relevant literature review are incorporated at appropriate junctures.

The Academic System in India and Its Impact on Writing

Writing Instruction and the Status of English in India

In the absence of a workable common Indian “link” language in the enormously complex multilingual Indian society, English has perforce become the “link” language for the educated in India. The Kothari Commission (1966) advocated the use of English as a “library” language, and as the language of instruction in all major institutes and universities. It also set a certain level of “proficiency” in English as a prerequisite for the attainment of a degree. The same Commission’s recommendation for the implementation of the three-language formula (a regional Indian language, a federal Indian language and
English) as an obvious first step for national integration and simultaneous promotion of regional languages in primary and secondary institutions in India has rendered the position of English in India somewhat ambivalent (Krishnaswamy and Sriraman 1995). In spite of the ambivalent status of English, it was awarded the status of an “additional language” by the Official Language Amendment Act of 1967. It is a “compulsory” subject at the undergraduate level and is taught at all schools regardless of socio-economic status (Nagpal 1995). The most important sociological impact of nurturing English in India has been the creation of a distinctive social division between the privileged few and the “Englishless masses.” Within the “putative-English speaking group” in India, there is a further stratification between those for whom English is the primary language of instruction in elite public/convent schools, and those who read English as a subject in vernacular government schools (Agnihotri and Khanna 1995). Nagpal (1995) identifies three categories of English learners within the Indian context based on widely differing social, economic and linguistic backgrounds: “elites,” “aspirants,” and “victims.” The minority elite trained in prestigious public and convent schools, although fluent in native language, “think, read and write” in English and have a “reasonable degree of linguistic and communicative competence” (87). The aspirants, on the other hand, are denied entry to convent schools and are trained in English-medium schools where they acquire “a degree of linguistic competence often falling short of communicative abilities – both in speech and writing” (87). The large majority of the victims are identified as those (often times, the “first generation of school-goers”) upon whom English is imposed as a compulsory subject in the sixth year of school, without any
compensation made for the absence of English in their social or cultural environment. Ironically, all three groups compete and write in the same major exit examinations at the end of the tenth and twelfth year (Nagpal 1995). The implications of this uniquely Indian English language teaching phenomenon for the present research is that Indian graduate students in the USA, although "holders" of the same university degree, possess very different writing skills in English.

Since the origins of English education in India can be traced to the British rule in India (for a more detailed historical background, see Appendix B), the emphasis on teaching the English language through literary works in English Literature has always been very strong. Consequently, the "pedagogies of literature teaching tend not to be sharply differentiated from the language mode" (Sunder Rajan 1995: 59). The questioning strategy for both is the same: "explication" and "testing of comprehension" of texts. This "language through literature" pedagogical practice of English teaching in India at the school and undergraduate levels ignores the need for developing professional communication skills. Commenting on the status of English education in India, Agnihotri and Khanna (1995) in their introduction to English Language Teaching in India: Issues and Innovations describe that the teaching of English in India

... has meant familiarity with, and paraphrase and interpretation of well-known English literary texts, in particular like Elizabethan, Restoration, Augustan and Romantic texts, involving largely a reproduction of received critical opinions. Most classroom lectures and examination scripts are often bad reproductions of popular "Kunjis" (help-books). Proficiency in English has generally implied felicity to quote Shakespeare, Milton, Burns, Pope, Keats or Eliot, or celebrated critics on them with relative ease .... The ability to negotiate day-to-day social encounters demanding the use of English and the ability to read texts critically in a socio-historical context rarely constitute pedagogical objectives. (p.14)
Slap-dash methods to throw in a few exercises on grammar and vocabulary in the belief that language skills may simultaneously be acquired through a study of literary texts have proved to be "untenable" in the Indian context (Sunder Rajan 1995; Nagpal 1995). The flourishing of "bazar institutes" and tutorial homes in most Indian urban centers to serve the communication needs of English-speakers in India (examination preparation, business writing, "spoken" English coaching) would point to the fact that the "mainstream" Indian education system is perhaps not fully succeeding in imparting basic writing skills to its students (Sunder Rajan 1995). According to some Indian researchers, the root of the problem lies in not treating English Language Teaching separately as a skills pedagogy for functional purposes (Sunder Rajan 1995). The fact that "literary English" is used in "non-literary contexts" is a result of the "excessive literary bias" in English studies in most South Asian countries (Mehrotra 1995:112-113). As an illustration of this point, at least one dissertation writer in microbiology in India interviewed for this research indicated that "in an attempt to write well," he is planning to begin with an appropriate poetic quote in his Introduction.

Recent Changes in English Writing Instruction in India

For historical reasons, the teaching of English language has received primary focus in the educational system in India. (For a more detailed historical background see Appendix B.) In recent times, however, the focus on English language instruction has waned. Although in certain "presidency" cities in India such as Madras in the South and Calcutta in the North, where the British had set up administrative centers, lingering influences of a classical system of education tend to persist (most notably, in convent schools), most of
the educational ministries in the different states of India have done away with the teaching and learning of the English language as a primary requisite. In the absence of a unifying and cohesive national educational policy, most states are left to determine their own language instruction policies (in compliance with the "three-language formula"), which are widely divergent. As a consequence, while in some states English Language is still taught from the kindergarten stage, in a few others it is not taught until the V or VI grade. Since till a few years ago most examinations and entrance-level examinations to major universities and institutes were held in English, there was some incentive to acquire basic writing skills in English to pass these exams. The very recent governmental policy changes (Ramamurti Commission 1990) which leave the option open to the student to write in any one of the 14 Indian vernacular languages has further eroded the privileged status of English Language in India (Krishnaswamy and Sriraman 1995).

The wider implications of such policy changes for the present research is that with the incentive to acquire basic writing skills in the English Language removed, recent Indian graduate students in the USA will find it that much harder to socialize themselves into western discourse communities. In fact, most of the science and engineering faculty interviewed in India, many of whom have research writing experiences in the USA or UK, point to deterioration in student writing skills as a consequence of such language policy changes. In a community of world readership, Indian science writers will have lost any edge they may have had amongst nonnative science writers. This fact, in part, may also explain the low output of scientific publications from India. Commenting on the deplorable writing skills of fresh engineering graduates from a local Indian engineering
school in a newspaper article entitled “Today’s Engineers: Importance of Learning English” in The Statesman\(^1\) (1997), Kamala Banerjee suggests that “they fail to write applications or prepare sensible reports.” Banerjee adds, that for graduates to be effective engineers, mere possession of adequate technological information is not enough; their education should be buttressed with competent communication skills. The low-priority status that the curriculum places on writing instruction in most Indian engineering schools produces writing that is characterized by verbosity, monotony, arbitrary tense changes and an inability to write “mechanism” or “process” descriptions (Banerjee 1997). Although certain Indian researchers such as Probal Dasgupta (1995) and Sunder Rajan (1995) argue for a more realistic curriculum in English rooted in Indian traditions, the recent spate of newspaper articles decrying poor writing skills in English of Indian students relate such a state of affairs to language policy changes.

**“Reproductive” Learning: Lack of Focus on Critical Skills**

The Indian educational system relies on text-based instruction that relies on memory-based skills. According to most respondents in this study, the academic system in India ignores the writing needs of students. Classroom instruction and questioning strategies for major examinations both at school- and college-levels encourage and facilitate rote learning and memorization skills. In a study of the “communicative processes” employed

\(^1\) The Statesman (circulation 164,000), founded in 1875, is one of the oldest English language dailies in India. It is the primary English newspaper in the state of West Bengal (http://www.thestatesman.org/aboutus.html). Widely respected for its balanced and honest “coverage of events,” it is considered by some as one of the ten elite newspapers in the world (Merrill and Fisher 1980). The editorial page in The Statesman often includes scholarly articles written by educationalists and experts on a wide variety of topics and issues of public interest.
by a teacher in a science classroom at a local college in the state of Maharashtra, India, Jacob (1987) suggests that the main processes included “explaining and understanding,” “repeating and reinforcing,” “meaning and labeling,” and “note-giving and note-taking” (209). The “questioning and answering” stage, focused on reproduction of “facts in the form of derivation and statements of structural and process descriptions” (e.g. “Enumerate various modifications of Zenkar’s fluid and state their importance”) (212).

Since the emphasis is on how closely the student has reproduced almost verbatim classroom lecture and text-based material, teachers largely ignore developing writing skills and implementing critical and argumentative faculties. Most examination questions assume a narrative or descriptive form, rarely analytical. This norm may vary according to specific university systems or institutes: some prestigious institutes such as the Indian Institute of Technology at Kharagpur, New Delhi, Madras and Kanpur, Indian Statistical Institute at Bangalore and Calcutta, or the Indian Institute of Science at Bangalore all modeled on western universities, encourage and foster the development of analytical and problem-solving skills. But by and large, the typical Indian student graduating from local or regional institutes is never trained formally in writing an argument or defending an independent point of view.

The problem is somewhat compounded, as one frustrated dissertation writer in India suggested, for those students who have graduated from local, regional, vernacular schools where the medium of instruction is the native language. The teaching of English in such schools is restricted to learning grammar rules, translating exercises from native tongue to English language or vice versa, or writing short essays from prescribed

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textbooks. There is also an over-reliance on using excessive "ornamentation" and flowery language. In other words, the Indian writing instruction system, such as it exists, pays less attention to organization, rhetorical structure and logical coherence than to ornamental language. Since this acquired knowledge in English is never used in terms of developing writing skills while writing for other subject areas such as history, physics or biology, most Indian students acquire minimal experience writing in English until the collegiate level. On the other hand, students who graduate from English-medium schools, or "convent" or "public" schools as they are more popularly known in India, acquire a marginal edge over their colleagues from vernacular schools in acquiring a greater degree of familiarity with writing in English.

Irrespective of the medium of instruction, opportunities for developing critical faculties are restricted in the average Indian school system. "In India, one is never encouraged to think on one's own — you are nervous of expressing your own opinion," explained an Indian science writer who has just finished writing her dissertation in the USA. As another dissertation writer in India pointed out, "I've sometimes had instructors who've encouraged independent and original thinking or debates in classrooms, but it's very rare. I was lucky to have a teacher who taught me to ask questions." As Eleanor McKenna (1987) suggests in "Preparing Foreign Students to Enter Discourse Communities in the US," nonnative students in American universities need to be taught when and how to ask questions in classrooms. Another dissertation writer in India from Indigenous Writers who has published two articles in international journals indicated that she found the academic system in India "not supportive or conducive to developing
writing skills – whatever I did I taught myself.” While the average Indian student produces perhaps more writing than the American student (through written assignments and writing essays in formal examinations), it is surprising to note the little significance the educational system attaches to providing writing instruction for students in India. It is, however, not surprising to note that with the exception of two or three respondents, all others in this study suggested that they had not benefitted from any kind of scientific writing instruction in India.

The survey suggested that the cumulative effect of coming from an academic environment marked by inadequate writing instruction and critical thinking ill-prepares the average Indian student, initially, to cope with the formal and structuralized writing demands of the IMRAD format, in which the statement of objective and substantiation of claim have to be made with some amount of confidence and rhetorical skill. “Since we have no practice in critical thinking, it affects our abilities to write—and is part of the difficulty in adjusting in the USA,” suggested an Indian graduate student from the Old and New Immigrants group. Another Indian graduate student from the same group who has just finished writing his dissertation in the USA confirmed this fact by suggesting that “in India, I never thought to question – just solved problems. In the USA, consequently, it was very difficult to frame a convincing argument.” This switch from a memory-based instruction system in India to a more rhetorically combative form of expression in writing in the USA can create a feeling of frustration, bewilderment, and inadequacy in beginner Indian science writers.
Indian faculty members in science and engineering both in India and the USA included in this study confirm the deleterious effects of the memory-based Indian educational system on their Indian graduate students. As one Indian faculty member in the USA pointed out, "It's not that Indian students are incapable of critical and independent thinking; they are very strong on verbal expression – adapt very quickly – and sometimes initiate very challenging discussions in the classroom. They are simply not trained to write in a similar vein. Because asking questions and arguing a point in the classroom is still considered an impertinence by many instructors in India, it is not hard to understand why many Indian beginner writers in the USA lack either the skill or the confidence to write assertively." According to another Indian faculty member in engineering, this deficiency in early training in India explains why most, if not all, Indian dissertation writers in the USA need to work on acquiring good rhetorical, argumentative and persuasive skills in writing. "I find that my Indian graduate students, although extremely competent, have no incentive to work on their own – I have to constantly tell them what to do – and I suspect, this largely arises from their habit of treating the word of the teacher as gospel truth," suggested another engineering faculty member in the USA.

Similar observations are made by native speaking faculty members in the USA (Group IV): "One interesting feature of most of my Indian graduate students is that prior to submitting a report or an assignment they always ask me, 'What do you want us to write?" Queries such as this one indicate the complete "dislocation" in both expectation of and response to a written assignment and the rather major rethinking and adjustment
that the typical Indian graduate student graduating from local and regional institutes in
India has to make or ought to be making in order to meet the writing demands of a very
different rhetorical situation in the USA.

Turning to broader cultural factors which inhibit the critical thinking skills of
international students, Helen Fox, in her book Listening to the World: Cultural Issues in
Academic Writing (1994), talks about the characteristic lack of “analysis” in the writing
of graduate students from Asia, Latin America, and Africa and attributes it to a different
set of cultural values and writing notions. Even other Indian faculty members
interviewed, while being critical of an academic environment that teaches an otherwise
bright and talented group of students “not to think,” point to Indian cultural traits such as
“excessive meekness,” “need to submit to an authoritarian figure,” and “reluctance to
argue” as contributory factors.

In attempting to distinguish between the writing styles of American-born native
speaking graduate students and nonnative speakers from other countries, Fox suggests
that while the former have been raised on western cultural ideals such as “individuality,”
“egalitarianism” and “originality,” the latter (especially, in China, Japan and India) “come
from societies that have for centuries valued the wisdom of the past over newness and
individual creativity” (54). The reliance on textbooks and the unquestioning acceptance
of the “top-down” teaching system with its twin emphases on learning by rote and
imitation would thus seem to be reminiscent of the Indian classical system of education
where paying homage to those of “greater knowledge and to timeless original wisdom”
(Fox’s term) is a way of life. The impetus to create something “new” and engage in
critical analyses of what others have said or written comes naturally to most mainstream American graduate students nurtured in an intellectually stimulating climate characterized by "innovation," "competitive capitalism" and notions of equality (Fox 1994). Indian graduate students, on the other hand, molded by the sentiments and beliefs of traditional conventions to venerate authority, tend to restrict such stimulating exchange of ideas in verbal discussions amongst peer groups and friends, refraining from expressing them in formal written discourse altogether. The comment of a dissertation writer interviewed for this research is revealing in this context: "Before I came to the USA, I used to believe everything – everything that is published must be good, but now I'm more critical; I don't accept everything I read."

It would appear, then, that before Indian beginner science writers learn to write according to the IMRAD format, the first step in the socialization process would be to consciously acquire writing skills amenable to critical synthesis. Brigid Ballard, in "Improving Student Writing: An Integrated Approach to Cultural Adjustment," in Common Ground: Shared Interests in ESP and Communication Studies (1994), summarizes numerous comments about Asian students attempting to adjust to the Australian system of education:

Asian students, who form the great majority of overseas students studying in Australia, come from a system of education in which the traditional attitude to knowledge was that of conserving and preserving the wisdom of the past and of the elders. The modern school system in Asian countries, for a variety of reasons, continues this tradition with emphasis on respect for the authority of the teacher, on rote learning and on passive classroom behavior. For students raised in such a tradition, the shift to analytical and critical approach to study is a major break with everything they have experienced in their previous education. (p.50)
Other Factors: Lack of Resources and Motivation: Stagnation

The survey confirmed that the lack of adequate library facilities in local and regional institutes in India can seriously limit the beginner science writer's necessary exposure to good scientific writing. Most regional colleges and institutes do not have the resources to stock up on recent books and scientific journals. This is not only detrimental in terms of the beginner scientist's attempts to keep up with recent research but also in terms of enabling the fledgling writer to read and learn a variety of writing strategies that skilled science writers employ while attempting to publish in refereed journals. All respondents, both beginners and skilled, interviewed for this research suggested that the increased availability of resources and research facilities in the USA contributed to and facilitated their attempts to learn to write in a manner acceptable to their community of peers.

Most respondents also felt that the Indian academic system did not provide an environment conducive for stimulating additional research. Since the focus of education is limited to gaining knowledge from prescribed textbooks, students at the Bachelor's and in some cases the Master's level do not find an impetus to seek additional research material to supplement information acquired from sometimes inadequate and outdated textbooks. As indicated earlier, the situation is somewhat different in certain prestigious institutes in India, but on the whole, beginner science writers aspiring to join western discourse communities are severely handicapped both in terms of keeping up with recent research and learning to write in a way that will enable them to participate in the knowledge-making process in science. "As a consequence," as one Indian faculty member in the Old and New Immigrants (Group II) astutely explained, "you find a situation where
most Indian graduate students just beginning to write in the USA find it very difficult to seek and incorporate reference material in the appropriate way ... or to place their research against a broader scientific framework.”

Publication Culture in India

Since all major universities, institutes and research laboratories in India are financed by the state or central government, the research apparatus is subjected to a great deal of bureaucracy and, according to graduate students and faculty members who were interviewed in India, the internal administrative system does not provide any inducement for publication. The promotion of faculty members is not determined by the number of published articles but by seniority. As indicated earlier, certain premier institutes which enjoy a relative amount of autonomy may provide a different kind of research environment – more in keeping with western universities – but on the whole, the impetus to conduct research and publish significant findings germinates wholly from within the writer. Likewise, the motivation for student publication also depends on the inclination of individual advisors (that is, student publication is reliant on advisorial approval). For most graduate students in India, writing the dissertation is the first attempt at formal writing. According to senior researchers in India, younger faculty display more interest and are more particular about writing (especially in rhetorical organization), than older and established researchers. Most researchers in India prefer writing for international and refereed journals, most commonly for American, British, and other European academic journals. Amongst those interviewed for this research, few had any experience writing for Indian scientific journals. According to two dissertation writers in India, “It’s not that
difficult to get published in average-level Indian scientific journals. They are not very particular about language. The only thing that you have to worry about is talking about something ‘new’ in big-sounding words. It’s different in cases of prestigious Indian scientific journals. They are almost as exacting as international journals.”

Faculty researchers who have been trained entirely in India (three respondents for this research) have an average of 18 publications, with some being in Indian scientific journals. Faculty researchers from India who have been trained in the USA, UK, or elsewhere in Europe, however, have impressive publications (ranging from 30 to 125 international publications and in some cases books). Amongst the graduate students interviewed in India, only two had international publications ranging from two to three papers. In general, drafts for international publication go through two to three revisions, although skilled writers make do with one or two. Most review comments pertain to suggested changes (substantiations, clarification, etc.) in technical content and organization. At least two drafts elicited review comments that referred to poor use of language. Although most researchers in India felt that foreign reviews generated balanced and constructive criticism, a few felt they were targets of a “big brother attitude.” The fact that Indian faculty members who have continued with their careers in the USA have extremely impressive publication records (ranging from 40 to 200 publications) indicates that an enhanced research environment with concomitant facilities and inducements for conducting research plays a significant role in the socialization process of Indian scientists. According to some Indian faculty members in the USA, Indian science writers from India in some ways have an edge over other nonnative speakers as far as familiarity
with the English language is concerned; however, the overall paucity of scientific
publication from India is largely due to outdated and inadequate literature review, lack of
vigorous research methodologies and poor organization skills. The somewhat low
publication rate from India can also be attributed to poor incentives that, as one faculty
member in the USA opined, are due to “the cultural abhorrence Indians have for writing.”

Changing Perceptions About Writing Among Indian Scientists

As Ballard (1984) points out, Asian students aspiring to join foreign universities
sometimes have to make a “double cultural shift” whereby they have not only to deal
with writing problems encountered by their native speaking counterparts, but also to
make room for a “major cultural shift in their styles of thinking and learning” (48). The
present section thus focuses on how Indian-trained science writers changed their writing
strategies and perceptions in attempts to overcome the educational and cultural obstacles
noted in the previous section. A review of the survey responses illustrates that in most
cases beginner Indian science writers have to spend a great deal of effort in adopting a
critical or argumentative point of view. The survey confirms that, like many Asian
students, Indian graduate students writing their dissertations in science and engineering
find the Introduction and Discussion sections with emphases on justification,
substantiation, clarification, and critical review most difficult to write. The
Methods/Methodology and Results sections on the other hand, relying mainly on
descriptive and narrative skills, are not perceived of as writing obstacles. A part of or an
extension of this primary problem is the need to learn to incorporate an appropriate
review of literature correctly. (See “Rhetorical and Organizational Changes” for details.)
However, respondents felt especially that they first had to learn to write more concisely. Almost all respondents felt that they learned to write in a way that eliminated repetition and redundancies and developed a greater awareness of clarity, economy of expression, and logical transitions. Some dissertation writers felt that learning to write in a “mathematical language” improved their chances of being published, that is, using more math and fewer words. Again, there is a possible cultural reason for wordiness in beginner Asian science writers. Helen Fox (1994) draws attention to preferences in certain cultures (India, China, Japan and African countries) for “subtle,” “indirect,” and “roundabout” communication strategies whereby a substantial amount of contextual and background information may be provided – even if their immediate relevance to the main point may not be obvious. Such “background” information, according to Fox, is provided to give a “feel” of the situation as opposed to the “low context” (indicating reduction in the need for contextual information) of American academic culture, where “getting to the point” and directness are valued:

... in cultures, which value directness, it is assumed that the reader needs to be shown exactly how any background information is tied to the ideas that the writer wants to get across. Not only do we require transitional words and phrases and a careful, logical ordering of information, but we expect reminders of our previous points from one paragraph to the next, as well as careful emphasis on words that show precise and explicit relationships between ideas .... But even in the writing of the more abstract disciplines at the U.S. university, there is an underlying tendency to directness, to precise relationships between verbs and their subjects, to clear and relatively obvious transitions, to announcements of intent and summary statements. Listening To The World (p.19-22)

Referring to the study by Scollon and Scollon (1981) on Athabaskan discourse, Fox suggests that the western discourse ideal for clarity can be traced back to the Protestant
Reformation where language became a “clear reflection of the orderliness of the natural world,” and that cultures devoid of its influence “continued to place an emphasis on social and rhetorical conditions, on the beauty and sophistication of suggestions, on multiple interpretations .... ”(44).

Tucker (1995), citing a study at Syracuse University comparing academic writing in English and native languages by nonnative students, similarly suggests that “lengthy introductions, digressions and extraneous details are essential elements of discourse” in many cultures. In “composition pedagogy,” such characteristic digressions may be viewed as “carrying over linguistic and rhetorical traditions of an academic discourse that is more abstract, speculative and elliptical”(6-7).

According to two faculty members interviewed for this research, the characteristic digression in Indian graduate student writing can be seen as an effect of elaborate rituals in the Indian religion and culture, and the “emotional” nature of most Indian languages. Given this cultural background, Indian graduate students, more used to writing long, rambling (digressive), descriptive essays, find the rigid and formatted writing of the western scientific discourse initially unfamiliar and on occasions uncomfortable. Not surprisingly, all respondents for this research suggested that clarity, organization, and transition in writing are some of the more important skills they learned after coming to the USA. This useful cultural distinction between the two kinds of discourses explains the extraordinary apparent contradiction in a statement made by one dissertation writer interviewed for this research: “I think I’ve become a better scientific writer after coming to the USA. Certainly I know all the rules now. I’ve been published in very prestigious
journals in my discipline, but I don’t enjoy writing it. There is no scope for humor, no scope for stylish writing.”

According to skilled Indian science writers who have extensive publication records in Old and New Immigrants and Foreign-Returned (Groups II and III), learning to write well is a gradual and “evolutionary” process. As one faculty member commented, “Your writing is a product of your association, reading, cultural environment and schooling .... Over the years I’ve become a better writer.” Other perceptual changes include developing strong rhetorical and persuasive skills: “I’ve learned to write in a way that takes into account other people’s views .... I’ve toned down ... become more persuasive ... don’t have tunnel vision anymore.” Overall, the general perception seems to be that Indian beginner writers learn to write in a more “professional” manner in the USA.

Although most respondents agreed that they learned effective writing strategies after coming to the USA, two dissertation writers and one faculty member suggested that their writing had not changed in any significant way. According to them, writing essay-type answers in the Indian examination system had taught them the rudiments of organization and structure: “Writing for scientific journals was just a matter of arranging the material according to the IMRAD format.” Some respondents felt that because of excellent schooling in India (e.g., schools modeled on western educational institutions), their expertise in the English language proved to be a distinct advantage in the USA.
Summary: Suggestions to Improve Science Writing Skills In Indian Education

The survey confirms that the socialization process of beginner Indian science writers into western discourse communities does not always necessarily include just doing away with errors and flaws but also learning to write and think in different ways. Baumgardner and Tongue (1984), in “The Problems and Potential of Exploiting the English Language Press as an Aid to Language Teaching In South Asia,” draw attention to the fact that when a language is transplanted and is used outside its natural setting, it changes features:

The culture and the language of a community are so fused that each shapes and refines the other and is in turn shaped and refined by the other. Where a language is divorced from its own cultural matrix and wedded to another one, where a language is used to fulfill certain important functions in a society where it is not indigenous, that is to say when it becomes a second language, it is bound to change and to develop features which are different from those of speakers of the language as a mother tongue. This is a natural, inevitable process. It has happened to the English language in many parts of the world, notably in Asia and Africa. Well-established and extensively described varieties of English in Asia include Indian English .... (p.134)

The problem, then, for beginner Indian science writers is twofold: to learn to think and write like a scientist and to rid their writing of the idiosyncracies characteristic of Indian English. Considering the “denotative” (Wilkinson 1991) nature of scientific writing, it would not be unreasonable to assume that once the beginner Indian science writer learns to deal with the former, the latter would also be taken care of; or in other words, since scientific method and rigor depends on the use of techniques and validation procedures that are universally accepted by the international scientific community at large, the “communicative potential” of any scientific discourse will ultimately depend on the validity of the scientific research conducted (Kuhn 1962; Tarantino 1991).
Respondents in India feel that because the use of English language is restricted and confined to the academy and for formal official communication only, in order for beginner writers, especially those who graduate from vernacular schools in India, to gain functional competence in the use of English, attempts should be made to expose them to the cultural nuances of British, American, and European cultures through books, films and other popular media in the English language. Reading of daily English newspapers is strongly recommended. The role of English dailies for the dissemination of popular English in South Asia has been documented (Baumgardner and Tongue 1988). Beginner science readers should also actively read “foreign” science publications – and study the writing included therein analytically. Rewriting is also recommended as an effective writing strategy for improving the quality of writing. According to a handful of respondents (three dissertation writers in India), writing instruction in English in the schools that they had graduated from had been so inadequate that it has left a lasting legacy of weaknesses in basic writing skills. For such students, a more comprehensive writing program focusing on grammar and organization would be beneficial. Although one Indian faculty member in India suggested that it is difficult to teach scientific writing, since it is largely “self-taught,” a few felt that intervention at specific points in the draft-writing stages could considerably improve writing. Most, however, suggested that sound research knowledge and clarity of thought were important prerequisites to “good” writing in science.
RHETORICAL AND ORGANIZATIONAL CHANGES

This section summarizes the responses of all Indian science writers interviewed for this study to the section entitled "Organization and Rhetorical Structure" in the questionnaire(s). In the Summary of Responses subsection, the findings will be presented under the three different groups separately according to the following categories:

IMRAD Organization and Citation. The number of textual deletions/additions/reshuffling in drafts will be presented according to a modified version of the Knorr-Cetina-Gosden classification system in Textual Revisions. In the Interpretation of Responses subsection, the implications of the findings will be discussed under the same categories as mentioned above. The comments of Native-Speaking Faculty (Group IV) will be integrated at appropriate places while discussing such changes.

Overall, the responses suggest that most beginner Indian science writers face difficulties with rhetorical organization due to a lack of adequate critical and rhetorical skills. Weak argumentative skills inhibit them from writing effective critical syntheses. A lack of awareness of using citations as a rhetorical tool accounts for the ineffective use of citations within the text.

Summary of Responses

Indigenous Writers (Group I)

IMRAD Organization. Most writers reported difficulties with the Introduction, Discussion and Conclusion sections. In the absence of any directional guidelines about writing and with the onus of writing placed squarely on the dissertation writer, it is hardly surprising that five of the dissertation writers who were interviewed identified almost five
different ways of organizing the rhetorical structure of the typical IMRAD format in their dissertations. Since none of the eight members in this group benefitted from any kind of scientific writing instruction in India, all adopt a “trial and error” approach towards organizing their research material. Two of the dissertation writers suggested that they allow the different sections and scientific aspects of their experimental work to dictate the larger structuring of their writings. In other words, writing is organized in such a way that it emphasizes the validity of the results obtained. Writing is organized hierarchically, with primary focus given to the major experiment and subsequent positions devoted to identifying the correlations between different experiments. A third suggested that he "freewrites" on the basis of points jotted down while conducting research until he has generated about 50 to 90 handwritten pages. This handwritten text is then later reorganized according to the organizational structure that is preferred by the journal in which he wishes to publish. This writer suggested that his rhetorical organization is influenced largely by attempting to address or explain "poor results" or anomalous behavior identified during the course of his research. Another writer suggested that he wrote almost the entire draft by following a Reader's Digest supplement on report writing, and is now in the process of rewriting the whole draft according to the IMRAD format. The fifth dissertation-writer, in his attempt to "rhetorically" highlight the significance of his work, found himself with a draft where he has narrated almost everything he knew on the subject. A rudimentary notion of writing according to the IMRAD format is, however, gained by reading published articles and studying drafts of senior students.
While almost all of the dissertation writers indicated that they found the Methods section the easiest to write, three out of five suggested that they found the Discussion section the most difficult to write. While one writer suggested that he found the "structure" of the Discussion section most difficult (principally to avoid repetitions), another indicated that she found it difficult because she had three different rhetorical goals to fulfill: to show continuity with existing work, to emphasize the significance of her work and to sound convincing. The third was unable to clarify why he found this section most difficult.

According to a young faculty member who has just started teaching and has 20 published articles in Indian and international journals, the Introduction and Abstract are most challenging because they are the most "saleable" items in a research article. In structuring the individual sections of the IMRAD format, he looks for continuity, logicality and validity in such a manner that rhetorically his article emphasizes the most significant points supported by reasons to establish validity. Another faculty member stated that he finds the Conclusion the most difficult to write because of the need to draw in all the relevant strands of information compactly to demonstrate the significance of his work.

Citation. Almost all of these writers use the literature survey as a starting point to devise their experiments by identifying a lack of research in relevant areas and subsequently devise theoretical/mathematical models to empirically validate the significance of results obtained. However, it is interesting that none of the dissertation writers in this group revealed an awareness of the rather important rhetorical role of citations in structuring an
argument. In fact, one writer suggested that she found it difficult to decide whom to include in her literature review. Furthermore, summarizing the works of others in a lucid manner was also a problem. The three faculty members in this group who are rather more experienced writers revealed a greater degree of familiarity with the rhetorical role of citations.

Textual Revisions. In the drafts of the beginner writers, most deletions and additions were done by the advisors to remove irrelevant material or clarify existing content. The number of textual deletions (on an average five to seven) are more than the number of textual additions (one to three) in a section/chapter of the Introduction or the Discussion in dissertation drafts/journal articles written by beginner writers. In almost all instances, the deletions were major, ranging from a paragraph to half a page of information. In cases of dissertation drafts, textual additions took the form of either handwritten insertions by the advisors or requests for clarifications or insertions of additional data. Reshufflings of sentences, whether within the same paragraph, page or elsewhere in the draft were few (on an average two). Modality changes were also few (about one to two). In some cases, the rewrites by advisors were so overwhelming that no useful classification can be made. General advisorial comments included requests for conciseness and brevity, avoidance of unnecessary data and phrases, need for appropriate and additional citation, clarification or explanation, rectification of inadequate data, substantiation and assumptions, and need for highlighting significance of research. Review comments for two articles intended for submissions in refereed journals point to the poor use of language. Although not representative, based on the strength of one draft...
provided by one skilled writer in this group, deletions for removing irrelevant material
appear to be more in number than addition. Reshuffling and modality changes are the
same ranging from one to two. (Please see Table IV.1.)

Old and New Immigrants (Group II)

IMRAD Organization. Depending on their respective lengths of stay in the USA and
individual writing skills, the graduate student writers faced varying degrees and kinds of
problems while coping with the demands of rhetorical organization. Three of these 13
writers in this group seem to have gained some sort of writing instruction at the college
level in India. Of the six graduate students, three are writing their dissertations and three
have just finished. One student suggested that she had had no concept of IMRAD or any
other format prior to her arrival in the USA. As a consequence, she had a great deal of
difficulty organizing and structuring the different parts of her thesis and project report in
the USA. Eventually, by studying other published work and with the help of her advisor's
comments, she learned to distinguish the different sections according to the different
aspects of her experimental work. One other dissertation writer also suggested that
though he had never written according to a rigid format or organizational structure prior
to coming to the USA, his writing experience in drafting general essay responses to
examination questions in India prepared him to make the transition to a more formal kind
of writing relatively less painful. According to him, since the Introduction in his
dissertation plays the most important rhetorical role, it undergoes the most revision.
Rhetorically, it "contextualizes" his problem-objective and establishes the element of
continuity in his research topic with research in related areas. The third dissertation
writer, who like the other two was unfamiliar with the structural and organizational parts of the typical IMRAD format, is just beginning to learn to write in this highly structured way by studying published papers and dissertations. On the whole, learning to organize writing according to the different aspects/parts of their experiments seems to be the first step towards writing in an acceptably formal manner for most of these beginner writers.

Two others who have just completed writing their dissertations suggested that reading well-written published articles and dissertations in the USA enhanced their existing notions of good rhetorical structure. While one feels that he writes in a more logical and "crisp" manner than before, the other went through major reorganizations and restructuring in the draft stage before he satisfied his committee.

The remaining five faculty members who have published extensively and are almost completely socialized seem to have overcome such initial writing hurdles. The socializing process for these very skilled writers included developing argumentative and rhetorical skills and a greater awareness for organization and presentation of facts logically and a skill in writing analytically. Two of these writers suggested that since graphics, models, tables and charts formed an integral part of their writing, text or prose in the Discussion and Results sections are supplemental and were merely a matter of interpreting trends.

**Citation.** Most of the dissertation writers in this group tend to find the Introduction, Discussion and Conclusion sections hard to write because they are analytical and interpretive, and interview responses indicate that a part of this problem seems to stem from a lack of a proper understanding of the role of using citations persuasively. These problems ranged from a lack of understanding of the need for using citations and poor
The two research associates who have obtained their doctoral degrees and are beginning to publish reveal interesting differences in their perceptions of the rhetorically persuasive role of citations. While one suggested that he finds the Introduction difficult because he "attempts to lead his readers to a pot of gold" by indicating what has or hasn't been accomplished in past research, the other who boilerplates extensively finds it difficult to write rather different Introductions for the same research material contoured for submissions in different scientific journals.

Of the five skilled writers, while one suggested that citation was important for providing a historical survey of what has been accomplished, another suggested that it was crucially important in the Introduction because a proper selection of citations outlined important areas of agreement and disagreement in that specific research area. A third suggested that it was important because it enabled him to offer an alternative hypothesis to an existing model. On the whole, all these writers suggested that writing the Introduction demanded all their rhetorical skills because it forged a link between their individual contributions with those of others and justified or validated their research.

Textual Revisions. In the dissertation drafts of beginner writers in this group, the number of deletions and additions are less than in Indigenous Writers (Group I). Unlike in the previous group, instances of advisorial rewriting are rare. The number of textual deletions in drafts was more (one to four) than the number of textual additions. The trend varied
from beginner to skilled writers. One beginner writer showed more affinity with the
previous group by showing more deletions than the average for this group. But, overall,
the number of deletions seems to be less for this group and are done by the advisors to
remove irrelevant material. Reshuffling was rare (one to two cases), but in two instances
involved major organizational and structural changes. Modality changes varied (one to
two). The most common kinds of advisorial comments on drafts of dissertation writers
include advice about emphasizing the significance of work, outlining the aim and scope of
dissertation, avoiding inappropriate interpretation, use of redundant or irrelevant data and
repetition, incorporating extensive citation and literature review, and clarifying or
justifying claims. One isolated instance of a comment suggested that the writer avoid
"copying verbatim from texts" without providing adequate documentation, the only
reference to potential plagiarism.

Deletions and additions for skilled writers were about the same (one to two).
Reshuffling and modality changes were also the same (one to two). A surprising trend for
very skilled writers in this group seems to be putting in "insertions" (my term) falling
somewhere in between "addition" and "reshuffling" of sentences. The review comments
on drafts for submissions in refereed journals written by skilled writers in this group are
markedly different. Most of the comments are relatively free from aspersions of poor
language use and pertain largely to requests for additional substantiations, clarifications,
reduction in the number of graphs, and additional literature review. (Please see Table
IV.1.)
Foreign-Returned (Group III)

**IMRAD Organization.** Like their counterparts in Old and New Immigrants, the seven skilled writers in this group reveal a sophisticated awareness of rhetorical organization. None of the writers in this group received any instruction in scientific writing either in India or in any other country, and like the skilled writers in Old and New Immigrants (Group II), these writers learned to write according to the IMRAD format while writing their dissertations or journal articles in the USA or Europe. Most of these writers suggested that the rhetorical organization was determined by the kind of writing: in a proposal the persuasive element was more well defined. While one writer suggested that the Introduction was rhetorically the most important since it outlined the significance of his work, another suggested that his entire rhetorical arrangement in a paper aimed at leading his readers to a punch line that encapsulated the significance of data generated by his research. One writer who uses an interdisciplinary approach suggested that he organized his writing according to the interrelatedness of his subject matter. Since the scope and range of his work is rather wide, he finds the Introduction "challenging."

Another writer, who has published extensively, indicated that he began writing by "fixing" the structure and organization of his paper. He considered the Introduction to be the most important section rhetorically, since it established the need and significance of his work and afforded him an opportunity for comparative analyses in cases where his methodology differed from existing ones. One other writer who has published in both academic and popular journals indicated that he continuously creates and recreates his goals and subgoals while writing. According to this writer, rhetorical significance lay in
writing clear and unambiguous prose. Both the Introduction and the Discussion sections, which consisted of collation, substantiation and analytical interpretation of facts, were considered important. All writers in this group begin by making some sort of a rough outline and refer continuously to laboratory notes made while conducting the experiments. One writer gets his first draft read by his students, which gives them ample opportunities to study the organizational skills of a skilled writer.

Citation. The opinion of the group is that citations are incorporated wherever there is a need to establish facts, contextualize material, and illustrate either continuity with or departures from established research traditions. Although most of these writers initially encountered some of the same writing difficulties that members in the two previous groups faced, years of writing practice have enabled them to develop a sophisticated awareness of good rhetorical organization.

Textual Revisions. The profiles of these very skilled writers who continue to publish after their return to India are very similar to those of the skilled writers in Old and New Immigrants (Group II) in terms of addition and deletion. Reshuffling was predominant (one to three). Most changes pertain to reorganization and restructuring of structural parts. Insertions within sentences or paragraphs are common. Review comments for one article included requests for modifications in assumptions. (Please see Table IV.1.)
<table>
<thead>
<tr>
<th>Group</th>
<th>Drafts</th>
<th>Text Deletions</th>
<th>Text Additions</th>
<th>Reshuffling</th>
<th>Modality Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Indigenous Writers</td>
<td>4</td>
<td>5-7</td>
<td>1</td>
<td>1-3</td>
<td>2</td>
</tr>
<tr>
<td>II Old and New Immigrants</td>
<td>3</td>
<td>1-4</td>
<td>2</td>
<td>1-2</td>
<td>2</td>
</tr>
<tr>
<td>III Foreign-Returned</td>
<td>x</td>
<td>x</td>
<td>1-3</td>
<td>x</td>
<td>1-2</td>
</tr>
</tbody>
</table>

x = Not applicable in this group.
Interpretation of Responses

IMRAD Organization

As novice writers, beginner Indian science writers face problems writing the Introduction, Discussion and Conclusion sections. Not surprisingly, interview responses obtained from skilled Indian science writers from India and the USA suggest that organizational problems that hindered them as beginner writers have been long since overcome. The socializing process for these very skilled writers included developing argumentative and rhetorical skills and a greater awareness of logical organization and presentation of facts. Interview responses from some of the dissertation writers, however, indicate that the same cannot be said of them.

In spite of the fact that Indian science writers are adept at organizing writing material for the typical descriptive essay-type questions that the Indian academic environment prefers, beginner science writers report considerable problems in organizing the structural parts in the IMRAD format. The comments of novice writers both in Indigenous Writers (Group I) and Old and New Immigrants (Group II) such as "I don't know where to put what" or "I don't know what expectations to fulfill," arise from an unfamiliarity with any coherent expectations about the internal structuring of the IMRAD format. By and large, all dissertation writers except two interviewed for this study indicated that they had problems with rhetorical organization. The responses of two Indian faculty members in India and the Native-Speaking Faculty interviewed at the LSU campus corroborate this fact. The responses of the dissertation writers interviewed for this research indicate that typically, beginner writers found the Introduction, Discussion,
and Conclusion sections more difficult to write. These were construed as "difficult" because of the need to appropriately justify, establish, collate or substantiate facts while making claims (see Summary section above). Shaw (1991) reports the same in his study of nonnative writers in Newcastle-Upon-Tyne, UK. Notably, the rhetorically far less complex Methods section was found to be the easiest to write by all dissertation writers interviewed for this study corroborating what Shaw (1991) found in his study with nonnative writers.

A review of revisions collected from the drafts of all three groups and categorized under "modality" changes would indicate how writers learn to "strengthen" (Knorr-Cetina's term), qualify or tone down claims, assertions or facts. The original (o) and revised (r) versions are provided:

Beginner Writers

1. **"Invertases occur in animal tissue, plant cell and microbes."** (o)
   
   **"Invertases are believed to be present in animal tissue, plant cell and microbes."** (r)

2. **"Because of multiple section images, one can guarantee 3-dimensional segmentation of the specimen."** (o)
   
   **"Because of multiple section images, one can arrive at a 3-dimensional segmentation of the specimen."** (r)

Skilled Writers

3. **"... the notion of risk involves both uncertainty and some kind of loss or damage."** (o)
   
   **"The notion of risk ... or damage. Uncertainty reflects the variability of our state of knowledge or state of confidence in a prior evaluation and can be defined as a set of doubtlets: \[ H = f(s_i, x_i, ... \{1\}, \text{ where } ... \] ** (r)

4. **"Localization of fluorescent ligand banding sites are of importance from several points of view."** (o)
"Localization of fluorescent ligand banding sites are of importance in study of protein structure function relationships." (r)

In the cases of beginner writers, "modality" revisions are made to tone down the levels of claims made. In example (1), "occur," connotating a degree of certainty, is revised to a more cautious "are believed to occur." Similarly, in example (2), while discussing the efficacy of a scientific procedure, "guarantee" is changed to "one can arrive at." In cases of skilled writers, "modality" changes in examples (3) and (4) are tempered by clarifications or by inclusion of additional information.

A related part of the beginner Indian science writer's problems with structural organization of the IMRAD format arises due to repetition and writing of irrelevant material. It may be this sense of "indirection" (Fox's term) combined with an unfamiliarity with the rhetorical structuring of the IMRAD format that explains to some extent the inclusion of repetitive and irrelevant "background" material in the dissertation drafts of most beginner Indian science writers in this study. Comments of some dissertation writers in Old and New Immigrants (Group I) and Indigenous Writers (Group II) indicate that they consciously attempt to do away with such writing traits to get published. As we shall see in "Grammar, Language and Vocabulary-Related Concerns" and "Identification of Some Typical writing Strategies," removing repetition is an important aspect of good writing according to the felt beliefs of almost all Indian science writers in this study.

In short, interview responses indicate that as part of the socializing process one of the first things that new graduate students from India learn in the USA is to write
according to the IMRAD format, develop a “point of view,” acquire critical skills, and understand the rhetorical distinctions between the Introduction, Discussion, and Conclusion. Such skills are acquired through writing term projects, assignments, reading and studying of past models in the form of well-written published dissertations and journal articles. Most writers in this study indicated that while in India, lack of scientific writing instruction obliged them to adopt a “self-teaching” approach. Furthermore, since publication is rewarded more in western academia than in the average Indian universities, beginner writers learn to change their pre-conceived notions about organization and adapt their writing to the more rhetorical demands of the IMRAD structure. Advisorial comments, models, and extensive reading facilitate the process. (In “Identification of Some Typical Writing Strategies,” we see these as significant factors in the socialization process.) Parkhurst's study (1990) of the writing processes of skilled native and nonnative science writers also corroborates this fact. The fact that dissertation writers in Old and New Immigrants (Group II) adopt several different ways of approaching the IMRAD format describing a trial-and-error strategy (see Summary), suggests that they have not yet mastered adequate rhetorical skills. In Vygotskian terms, these “neophyte” Indian science writers, through extensive reading, writing instructions and interactions with the other researchers such as peers and advisors through review of rough drafts learn to fulfil the genre-specific requirements of their chosen areas.

Of the five Native-Speaking Faculty interviewed, all suggested that their Indian graduate students were competent writers, whose sense of rhetorical organization could be improved. Significantly though, they also felt that these problems were not very
different from what their native speaking students experienced. Interestingly, in a Stanford-based study, science and engineering faculty felt that while there was not much writing difference between their native and nonnative speaking graduate students at the discourse level, most problems for nonnative writers cropped up at the "surface-level" (Casanave and Hubbard 1992).

Thus, such problems related to writing the rhetorically complex Introduction, Discussion, or Conclusion sections are not confined to nonnative or Indian beginner writers. As Ballard (1984) and Shaw (1991) point out, all beginner writers upon entering the university need to make a “cultural shift” (Ballard’s term) where they learn to use highly specialized language, think critically, and evaluate the work of others.

Citations

A necessary and integral part of the rhetorical structuring of the IMRAD format hinges on the skillful use of citations. Knowledge-making in science is cumulative, and the conversion of a hypothesis into a scientific fact depends a good deal on how successfully the writer has established his evidence for a review by his community of peers (Popper 1962; Ziman 1984). Part of this process includes delineating how the present research of the scientist has deviated from or continued with existing research methodology (Popper 1962; Ziman 1984; Bazerman 1989). Latour and Woolgar (1979), Myers (1990) and Ziman (1984) tell us that a characteristic of rhetorical maneuvering is the skillful use of citations as a persuasive strategy. The interview responses of the skilled Indian science writers in all the three groups indicate that they are fully cognizant of the rhetorical role of citations, and as fully socialized members of their discourse communities keep abreast
of scientific developments in their areas. In fact, for many of these skilled researchers, the literature review is the starting point towards devising their own experiments through identification of anomalies or a lack of research in relevant areas.

Interview responses from some dissertation writers, on the other hand, such as "who and how much should I cite," suggest that part of such rhetorical blindness may arise from an unfamiliarity with the rather important role citation plays in the knowledge-making process in science. While in a few isolated cases citations are considered redundant since the research topics are based on such new methodologies that no extant literature exists (as in the case of one dissertation writer in India working on medical imaging), it is interesting that most of the dissertation writers in Indigenous Writers (Group I) and a few in Old and New Immigrants (Group II) do not reveal an awareness of the important rhetorical role of citations in structuring an argument. The comment of one interviewee is particularly instructive in this context: "In India, the focus was on what I did — not on what others did." Although this may not be taken as a generalized statement, it does reveal, to some extent, the condition of a research environment constrained by inadequate library and research facilities where new entrants to discourse communities remain unfamiliar with the use of the "formal linking mechanism" (Ziman’s term) through citations in scientific communication. Conversely, the same system has produced a dissertation writer who has already published two articles in reputed international journals. Depending on the kind of research institute the writer attended in India (see "Cultural, Rhetorical and Writing Contrasts"), Indian beginner writers acquire variable writing skills that affect their socializing processes in different ways.
For the Indian graduate student from an average Indian university, however, who is more used to writing text-based descriptive responses to examination questions, the socializing process includes switching to an argumentative mode revealing not only a thorough knowledge but also a skillful use of citations within the traditional IMRAD format, especially while establishing original claims. Dong (1996) reports similar problems regarding the use of citations with three Chinese doctoral students in science. Two of the Native-Speaking Faculty (Group IV) members felt that in the "Review of Literature" section written by their Indian graduate students they had difficulty in distinguishing between what the student did and what others researchers in the area have done. In other words, such writing blurred the rhetorical and very real distinction between past research and present work. Text-based activities such as critically reviewing or synthesizing material from other sources were reported to be a major problem by most beginner writers in Indigenouse Writers and Old and New Immigrants (Groups I and II). This is perhaps why it is not uncommon to see some beginner writers quoting texts at random from their source material. Shaw's study (1991) and St. John's study (1987) with proficient Spanish science writers also note this to be a common practice. Four out of five members of Native-Speaking Faculty (Group IV) agreed that most beginner graduate student writers from India faced problems with such text-based activities. Cadman (1997), in her analysis of the "identity problem" in thesis writing by international students, situates such writing problems in the "different epistemologies in which [they] have been trained" (5). According to her, much of the confusion that arises in the nonnative students' attempts at literature review is due to a failure in "select[ing]
language which simultaneously create[s] a voice” of their own within the text (7). It is perhaps no surprise that Ramani (1987) in her article on the need to revise/edit a syllabus for science and engineering students in the Indian Institute for Science, Bangalore, recommends writing instruction on synthesizing research material from source materials.

Advisorial comments on the drafts of dissertation writers in Old and New Immigrants (Group II), such as on the need for emphasizing the significance of work, need for extensive and appropriate literature review, and the need for avoiding verbatim copying (only one instance), indicate that the socializing process for such beginner writers include not only keeping up with the recent developments in research, but also learning to write a critical review of such research and using citations as rhetorical tools in structuring an argument. As using citations is an integral part of establishing claims, justification and substantiation of facts within the IMRAD format, beginner writers previously unfamiliar with such organizational requirements learn the rules of citation while simultaneously learning to write according to the IMRAD format through reading published literature and rewriting drafts.

Textual Revisions (please see Table III)

That beginner writers tend to have problems in sections where such text-based and rhetorical skills predominate is also well illustrated by the larger number of deletions and rewrites in their drafts. A review of drafts written by dissertation writers in Indigenous Writers (Group I) indicates that there are more deletions than additions. General advisory comments requesting brevity and avoidance of irrelevant data suggest that there is evidence of including repetitious, redundant, or inappropriate material. In his
study of drafts produced by Japanese graduate students for research articles, Gosden (1995) found that 61% of the revisions were in sections where there was a need to justify a claim, establish a fact, or state a purpose. An analysis of dissertation drafts produced by dissertation writers in Indigenous Writers (Group I), shows that some major deletions have been replaced by written insertions by the advisors. The fact that in some instances, the deletions and rewritings are done by the advisors would suggest that these novice writers have not yet learned to write according to the demands of their discourse communities. Such direct intervention by advisors in the draft-writing stages is perhaps also the only way such writers can be taught to write in an acceptable manner, especially in the absence of formal scientific writing instruction. In her study of faculty impressions about nonnative student writers in science and engineering in six American universities, Jenkins et al. (1993) found that faculty did about 25% of the rewriting for their nonnative students as opposed to 10% for native students.

A comparison of the number of additions/deletions/reshuffling/modality changes made by dissertation writers in India (Group I) with those produced by dissertation writers in the USA (Group II) would indicate that the numbers are less than the numbers produced by Group I, suggesting perhaps that once these beginner writers are exposed to research environments in American universities, they become more familiar with the genre requirements. (This observation may contain some bias because graduate students in India, due to a lack of access to computer facilities, tend to retain laboriously successive handwritten drafts which codify the deletions/additions and rewrites. A lot of these changes are lost in the successive drafts written in the USA on the wordprocessor).
Although the deletions in the drafts of dissertation writers in the USA (pertaining to the removal of irrelevant material) are made by the advisors, instances of advisorial rewritings are rare. However, the advisorial comments on the drafts of dissertation writers both in India and the USA show a considerable amount of overlap, such as the need for emphasizing the significance of work, outlining the scope and aim of dissertation, avoiding of repetition, and including more citations, suggesting that as beginner writers they share some common problems which they have to overcome to socialize themselves.

A review of drafts of skilled writers indicates that while additions/deletions generally decrease, insertions and reshuffling increase perhaps indicative of the recursive process of writing of skilled writers. Most of the review comments on the drafts of journal articles written by these skilled writers pertain to requests for additional substantiation, clarification, reductions in the number of graphs, and modifications in assumptions. They reveal, as Myers (1990) and Bazerman (1989) point out, the negotiations between the writer and her community peer group in the knowledge-making process in science. That most of these comments are relatively free from aspersions regarding language use, citations, and rhetorical organization may be construed as a working hypothesis that these writers have indeed been socialized into their respective discourse communities.
GRAMMAR, LANGUAGE AND VOCABULARY-RELATED CONCERNS

While in the preceding section we looked at the various aspects of organizational and rhetorical changes that beginner Indian science writers have to make to socialize themselves into western discourse communities, this section focuses on their grammatical, language, and vocabulary-related concerns.

As in the previous section, this section too, is divided into two broad subsections: Summary of Responses and Interpretation of Responses. In the Summary subsection, information gathered from the interviews is presented under the three different groups of Indian science writers according to the following categories: Grammar and Language and Vocabulary. In the Interpretation subsection, implications of such findings will be discussed in light of existing knowledge under the same categories. Attempts have also been made to identify certain illustrative examples of revisions relating to the use of heavy nominalizations, reference, and tense-related problems from the drafts of beginner writers. These, and the comments of Native-Speaking Faculty (Group IV), will be incorporated into the Interpretation section at appropriate places.

Briefly summarized, the responses of the beginner Indian science writers indicate that minor but persistent grammatical problems include ineffective sentence construction, weak cohesion, tense and incorrect article use. Writing shorter sentences is viewed as a corrective. Removing repetition and writing with clarity are other language-related concerns. All writers express a desire for increased vocabulary.
Summary of Responses

Indigenous Writers (GROUP 1)

Grammar and Language. The general problems in this group include those related to sentence construction, repetition, and clarity. The five beginner writers in this group who are in different stages of writing their dissertations suggested a variety of writing problems. Four out of five of these beginner writers indicated that they had problems with sentence constructions. While one suggested having problems with sentence constructions in general, the other mentioned having problems while writing complex sentences ("My sentences are too long"). A third suggested that "after I've finished writing, I understand what I've written; others don't." The fourth suggested that he faced problems while trying to combine sentences and transforming direct form to indirect form. Two suggested that they had problems in developing transitions. Three out of five reported tense-related problems. The most common problems relate to use of past and present tense, appropriate use of singular and plural, and the third person singular. One suggested having problems with pronouns and prepositions. Three out of five suggested having problems with the use of the definite article "the."

In the cases of the three faculty members in this group, some of the writing problems reported by the novice writers tend to linger. Although none complained of having problems with sentence constructions in general, two of them still have problems with tense. One still has a problem with the use of the definite article "the." Overall, all writers in this group expressed the desire to write in a way that was free from repetition, "padding" and ambiguity and "ornamentation." Repetition also seems to be a common
problem. The ability to write something significant in a clear, lucid, concise and logical manner was rated highly by all of these writers. One dissertation writer expressed difficulties in effectively summarizing the works of others. She also suggested being strongly influenced by the "style" of other writers. One dissertation writer also expressed the desire to write so that it reduced the necessity of using too many mathematical formulae. One faculty member and one dissertation writer stressed the importance of using unambiguous language for fear of being misinterpreted by their community of peers.

**Vocabulary.** Three out of the five dissertation writers indicated problems with vocabulary. For most of these writers, the problem seems to be hunting for the exact terminology or equivalent word-choice in the English language. Only one faculty member out of three suggested that he spends considerable time "hunting for the most perfect expression in the process of translating from my mother-tongue to English." (Please see Table IV.2.)

**Old and New Immigrants (GROUP II)**

**Grammar and Language.** Of the six dissertation writers in this group, three expressed problems with sentence constructions. "Sometimes due to the pressure of work, grammar goes all wrong – I sometimes can’t read what I’ve written myself" was the comment of one frustrated writer. A second suggested that his problem ran in the nature of "how do I say this to convey what I want to say." The third writer was unable to specify the nature of his problem in respect to sentence construction. Only one of these six writers suggested having tense-related problems, such as switches between active and passive
voice. Three indicated having problems with transitions. One suggested that to avoid transition problems “I always try to write two sentences as a ‘connective,’ but that becomes repetitive.” Two reported problems with articles. Overall, these writers aimed for clarity and logicality in prose. While one suggested that she would like to avoid “flowery language” and write in a manner that is clear to a “layman,” another suggested that he would like to avoid using a convoluted writing style. A third suggested that he would like to write in an unambiguous way that did not leave him open to multiple interpretations. The same writer also suggested his inability to write in “layman’s terms” (“I always end up using mathematical language”) and his desire to avoid repetition.

In cases of the seven skilled writers in this group, a lot of these concerns have been adequately dealt with, but some traits tend to linger. Two of these seven writers who have only recently obtained their Ph.D. degrees and have begun to publish suggested having tense-related problems. As one of them explained in an example, “How do you differentiate between the two?: ‘This study was carried out’ or ‘This study is being carried out’ or Which is right – ‘as shown below’ or ‘as follows’?” This same writer suggested that he tended to overuse the past tense, and that his dissertation adviser changed such usages to the present continuous. The second of these two writers suggested that he tended to write long and convoluted sentences with too many clauses.

Of the remaining five skilled writers who have been completely socialized into their respective discourse communities, all of them suggested that over the years they have learned to overcome writing problems such as tense-related problems, punctuation errors, overuse of adjectives, and transition and article related problems. Only one of them
suggested that he still sometimes has problems with articles. More specifically, all of them emphasized the fact that they learned to write clearly, logically, and concisely. In other words, each of them in their own way acquired a writing style that was rid of verbosity, especially unnecessary flowery language, adjectives and repetition. One common survival strategy seems to be learning to write in shorter sentences to avoid tense- and transition-related problems. While one reported having problems with transformation of sentences, the other suggested an overuse of the passive voice.

**Vocabulary.** All six of the dissertation writers in this group suggested that they faced occasional problems with vocabulary. Three writers reported overuse of hedging words such as "however" and "since." One writer suggested (as an example) that his problem lay in often pinpointing the correct choice as in these two versions: "simplistic view" or "a simplified view." A third writer, interestingly, suggested that while his technical vocabulary improved after coming to the USA, his general vocabulary or stock of words deteriorated because he doesn't have the time to read books on general interest.

Of the seven faculty members, only two suggested that they still sometimes had problems with finding the exact word. (Please see Table IV.2.)

**Foreign-Returned (GROUP III)**

**Grammar and Language.** As faculty members in India, all seven agreed that some of the common writing problems of most beginner Indian writers could be characterized by use of long sentences, use of several qualifiers leading to tense-and-transition related problems, use of flowery language and adjectives, and problems with articles. One suggested that his students tend to have problems with prepositions and pronouns. Two
<table>
<thead>
<tr>
<th></th>
<th>Sentence Construction</th>
<th>Tense</th>
<th>Article</th>
<th>Cohesion/Transition</th>
<th>Vocabulary</th>
<th>Importance of Clarity/Removal of Repetition</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Beginner</td>
<td>Skilled</td>
<td>Beginner</td>
<td>Skilled</td>
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<td>1</td>
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<td></td>
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</tr>
</tbody>
</table>

N = Total number of respondents
x = Not applicable in this group
suggested overuse of “hedging words.” Lucidity, clarity, brevity, logicality (good reasoning and argument), unambiguity, and learning to write with as few adjectives as possible were some of the writing skills that were strongly encouraged.

Like the skilled writers in Old and New Immigrants (Group II), the skilled writers in this group have learned to overcome tense-related (“has been,” “is,” passive/active voice) and article related problems. Almost all of them suggested that although, initially, they had tended to write longer sentences with too many qualifiers, learning to write shorter sentences has enabled them to achieve two objectives: avoid grammatical errors and develop a clear, logical, and concise writing style. One of the writers suggested that he still had problems in putting proper emphasis on the significant part of the sentence.

**Vocabulary.** Only one of the seven writers in this group suggested that he still sometimes faced problems looking for the right word. The same writer suggested that he lacked appropriate vocabulary in “colloquial English.” (Please see Table IV.2.)

**Interpretation of Responses**

**Grammar and Language**

Notwithstanding the fact that individual writing skills tend to differ both in nature and degree, the interview responses suggest that Indian-educated beginner science writers show some common writing problems not also found in native speakers. These include the tendency to write long, convoluted sentences with too many qualifiers, leading to problems in transitions and tense, and the appropriate use of the article system. Furthermore, most writers revealed concern over the use of flowery language characterized by an overuse of adjectives. Repetition and verbosity, though not
necessarily grammatical errors (arising mainly out of organizational flaws), were also stated as problems. (See previous section “Rhetorical and Organizational Changes,” Chapter 4.) A review of the responses and drafts of the very skilled writers indicated that one way they consciously seek to overcome some of these problems is to write shorter sentences, aiming for a more pithy and concise writing style.

Generally speaking, sentence-level problems indicated by the respondents conform to those noted for other nonnative speakers by earlier studies. In their study of faculty impressions about the writing differences between native and nonnative speakers in the sciences and humanities, Casanave and Hubbard (1992) found that although “word and sentence-level criteria” (including accuracy of grammar, size of vocabulary, spelling and punctuation) were not considered as important as “discourse-level criteria” (including organizational features), nonnative speakers tended to have more problems with correctness of punctuation and spelling, appropriateness of grammar, and vocabulary. More typically Asians, such as nonnative speakers from Japan, Korea, Taiwan, and the People’s Republic of China, tend to have more problems than others. Conversely, another study of faculty impressions about nonnative doctoral students in science and engineering found that over 70% (out of 173) of the faculty attached considerable importance to grammar and vocabulary (Jenkins et al. 1993). The same study suggested that faculty used different standards to evaluate the writing of nonnative speakers, and a quarter of the faculty included in the study made allowances for writing by nonnative speakers. Although at odds with each other, both these observations have some merit as illustrated by the comment of one very skilled Indian science writer in Old and New

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Immigrant (Group II) on the writing of one of his nonnative students: “To me good writing is faultless logic and reasoning in devising mathematical models—even if it’s in half-broken English.”

Turning to specific problems, interview responses reveal that for most Indian beginner science writers who are familiar with the rudiments of English grammar, most grammar-related problems tend to arise from a tendency to write long, complex sentences. Example (1) from a dissertation draft written in India indicates that sometimes grammatical errors creep in due to heavy nominalization arising out of inappropriate insertions of qualifiers. The original (o) and revised versions (r) are provided:

(1)"The scrapers whose litter breakdown capacity was to be studied Bellamya, Thiara, and Gabbia (of the size group mentioned as above respectively) were kept in uniform glass acquaria (15x 15x20 cm) under the same conditions 10, 25 and 26 respectively in each of the container respectively.” (o)

“The scrapers Bellamya, Thiara, and Gabbia (of the size group mentioned respectively) were considered for studies. For each set of experiments, 10 Bellamya, 25 Thiara and 25 Gabbia were taken. They were kept in glass aquaria ... under similar conditions separately as regards to species.” (r)

In the original version, confusion arises due to the inappropriate insertion of the qualifier “whose litter breakdown capacity was to be studied” within the main noun phrase “the scrapers .... ” In the revised version, only marginal improvement is gained by breaking the overly-long sentence into three shorter sentences.

Master (1991) suggests that the use of active verbs with inanimate subjects is prevalent in scientific prose, but nonnative speakers, particularly Asians, tend to find this use difficult, and as a consequence heavily nominalize the verb form. Finnish writers also
are reported to have problems with heavy nominalizations and cohesions (Ventola 1993). Other grammar-related problems (although, not in significant numbers) for some beginner Indian science respondents include appropriate usage of present/past, singular/plural and active/passive. As examples (2) and (3) from the drafts of two beginner writers indicate Singular/Plural errors arise from an ignorance of whether the subject-noun is collective or not.

(2) “The litters entering the pond were collected once a month during the study period .... The wet litter retrieved from the pond surface were dried and weighed.” (o)
“The litter entering the pond was collected once a month during the study period.... The wet litter retrieved from the pond surface was dried and weighed.” (r)

(3) “Coronal garnet of different thickness often showing sieve texture are present ....” (o)
“Coronal garnet of different thickness often showing sieve texture is present....” (r)

Like many other nonnative writers, Indian science writers are frustrated by the English article system. Master (1987) suggests that the English article system is one of the most difficult things to master for a nonnative speaker. Presumably, as one skilled Indian writer in Old and New Immigrants (Group II) suggested, it is because there is no equivalent for it in any of the main Indian languages. Tucker (1995), however, suggests that such problems relating to the article system arise because many nonnative writers are not used to “thinking in terms of mass or countable nouns” and that it is “often the last skill to be acquired by both first and second language learners.” Ventola (1992), in his study of writing by Finnish researchers, suggests that cohesive reference chains in texts
are broken due to absence or misuse of pronouns, proper names and the article system (a, an, the, some, they, these). A glance at some of the examples listed from (4) through (7) from drafts of dissertation writers in India and the USA illustrates this point.

A combination of problems with the article system and a tendency to write long sentences probably also accounts for the transition or problems associated with thematic progression stated to be faced by most beginner Indian science respondents. James (1984), in his study of the writing of a nonnative student in the UK, suggests that "blurring of meaning" can also arise from "functional incoherence."

(4) "The leaves of these three plant species were taken to have them at different states of decay. Leaves were collected from the water surface of the pond immediately after they fall." (o)
   "The leaves of these three plant species were taken to have them at different states of decay. These were collected from the water surface of the pond immediately after they fell." (r)

(5) "Since the same fragments... it provides clear evidence...." (o)
   "Since the same fragments... these studies provide clear evidence ...." (r)

In example (4), in the revised version, the insertion of "these" helps establish thematic coherence between the two sentences. In example (5) a mistake in the use of pronouns leads to faulty referencing.

(6) "In recent years, yeast invertase which is glycoprotein has been used as a probe ...." (o)
   "In recent years, yeast invertase, a glycoprotein has been used as a probe...." (r)

(7) "Simulation experimentation has been in use since 1950s .... " (o)
   "Simulation experimentation has been in use since the 1950s .... " (r)

Examples (6) and (7) illustrate the case of missing articles.

In copies of review comments sent to two dissertation writers by refereed journals in Indigenous Writers (Group I), references were made to "poor language use." It was

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also not uncommon to find comments such as “repetitive” or “redundant” in the drafts of some beginner writers in India and the USA.

All Indian science respondents emphasized the importance of writing with clarity. Perhaps this concern is not misplaced, as three out of the five native speaking faculty in Group IV suggested that although their Indian graduate students were competent writers, some of their problems included improper article use, learning to write clearly in an unambiguous manner, incorrectly constructing sentences, and the ineffective use of transitions. This emphasis on clarity is also not surprising since the overall objective of academic scientific writing is to gain consensus from a community of peers (Popper 1962; Ziman 1984). According to these skilled writers, learning to write with clarity in scientific writing arises from a sense of good organization, incorporation of appropriate citation, and clarification of scientific validity and evidence. For beginner writers in his study, some of whom have not yet grasped the overall implications of “clarity” in writing that the more skilled writers seem to share, the notion of “clarity,” however, is associated with removal of repetition and the acquiring of impressive vocabulary both in technical and non-technical areas. Thus, it would appear that beginner writers need to gain a more holistic appreciation of clarity to write in a manner that is acceptable to their respective academic communities.

Casanave and Hubbard (1992) suggest that writing skills in science and engineering communities in most American universities are considered important only towards the end of the students’ doctoral education. This would imply that some writing problems are carried over and retained by nonnative speakers for some time while in the
USA. Quite appropriately, thus, we see some of the same kinds of writing problems or to use Tucker's term (1995), "fossilized errors" (article use, transition, tense, repetition) shared by the Indian dissertation writers in India and the USA.

An important factor to keep in mind, however, is that the average age of the skilled Indian science writers interviewed for this study fell somewhere between 40-65, indicating that most of these writers prior to arriving in the USA/UK benefitted from educational policies in India (see "Cultural, Rhetorical and Writing Contrasts" in this chapter) that attached some importance to English language instruction and were, therefore, relatively familiar with the rules of grammar. The younger generation of dissertation writers interviewed for this study, on the other hand, were beneficiaries of language policy changes that encouraged native language instruction. Secondly, a perception that seems to exist commonly amongst dissertation writers is that the extent to which writers are prone to making grammatical errors is determined by the kind of schools that these writers attended in India. It would appear that dissertation writers who attended convent/public schools in India, where the language of instruction was English, had some advantage over those who attended native vernacular schools in terms of being more easily socialized into western discourse communities. While this may be true of some dissertation writers interviewed for this study, it is not applicable for the older generation of skilled Indian science writers for reasons outlined below.

The skilled Indian science writers, on the other hand, having benefitted from a more focused English language instruction in India, and through years of writing practice in western universities, have learned to overcome such writing problems associated with
tense, punctuation, adjectives, transitions, and articles. In general, the number of corrections or revisions in terms of article use (a, an, the), tense, singular/plural use and appropriate word choices in drafts decreases as we move from beginner to skilled writers in Indigenous Writers (Group I) and Old and New Immigrants (Group II). While the dissertation writers in both groups show significant revisions in these respects, the frequency of such revisions is much reduced in the drafts of the skilled writers in Old and New Immigrants (Group II) and Foreign-Returned (Group III). In fact, in the drafts of skilled writers, I was hard put to detect revisions relating to such grammatical and language concerns. It is, however, important to keep in mind that due to word-processing facilities in the USA, revisions or corrections in successive drafts tend not to be recorded.

**Vocabulary**

Although Casanave and Hubbard's study (1992) found that the appropriate use of vocabulary was ranked fifth in importance by faculty in science and engineering, almost all beginner writers in India and the USA interviewed in this study expressed concern about the "most perfect word." Citing Jonz (1990), Casanave and Hubbard point that "lexical choice represents higher order thinking rather than a locally constrained choice" (1992: 42). If Bazerman's interpretation and application of the Vygotskian model of language activity to a social analysis of language use in science is valid, one would assume that beginner dissertation "neophyte" writers would, gradually, in the process of socializing themselves into their respective discourse communities, learn to use appropriate terminology. A review of the responses and drafts of the Indian science writers across the three groups illustrates this point. The drafts of the dissertation writers
in India contained innumerable revisions in vocabulary. The frequency of such changes is fewer in the drafts of the dissertation writers in the USA. They are occasional in the drafts of the very skilled writers in all the three groups. The examples cited from (8) through (11) indicate that while some changes in the drafts of the beginner writers are technical in nature (suggesting that they are still learning discourse-specific terminology), the changes in the drafts of the more skilled writers are more directed towards perfecting the most exact expression. Most revisions in the drafts of skilled writers in Groups I, II and II consisted of vocabulary/word-choice changes, “insertions” and occasional transformation of sentences.

(8) “Prior to analysis the samples were washed through B.S. 120 seive 0.5mm pore size.” (o)
“Prior to analysis ... 0.5mm mesh size.” (r)

(9) “... is pretty much identical ....” (o)
“... are very similar ....” (r)

(10) “In the clinopyroxene rich rinds the dominant .....” (o)
“In the clinopyroxene rich band the dominant .....” (r)

(11) “Solubility of water in silicate melts has three almost equally dramatic effects.” (o)
“Solubility of ... equally drastic effects.” (r)

In example (8) from the dissertation draft of a beginner writer, “pore” replaces “mesh” indicating a qualitative preference for a more technical connotation. In example (9), also written by a beginner writer, the colloquial “pretty much identical” is replaced with the more formal “are similar.” In the final two examples written by skilled writers, while “rind” is replaced with “band,” suggesting a more precise replacement, “drastic” replaces
"dramatic," revealing a preference for a more toned down version to indicate the large changes in the properties of silicate melts. (For additional samples, please see Appendix D.)

The overwhelming concern to improve the technical and non-technical vocabulary perhaps explains why some dissertation writers interviewed for this study indicated that they learn "better ways of expressing" themselves by making a list of "useful terms and phrases" (discussed in more detail in "Identification of Some Typical Writing Strategies") from published literature and incorporating them within their texts. Parkhurst's (1990) study suggests that nonnative science writers are more concerned with the differences in technical vocabulary between spoken and written registers than native science writers. That beginner Indian science writers interviewed for this study are not alone among other nonnative science writers in expressing a desire to improve vocabulary is confirmed by the studies of Shaw (1991), St. John (1987) and Sionis (1995).

**IDENTIFICATION OF SOME TYPICAL WRITING STRATEGIES**

In this section, the responses of all Indian science writers in the three different groups to the sections entitled "Writing Activities" and "Writing influences: Sources and Feedback" in the questionnaire(s) are summarized to identify certain common strategies that Indian science writers employ. Furthermore, attempts are made to detect "message adjustment" and resource-expansion" strategies as identified by Claude Sionis (for details, see Chapter III) from information gathered from responses to the questionnaires, review comments made by advisors, or refereed comments on drafts of dissertations and scientific papers.
As in the previous sections, this section is divided into two main subsections:

Summary of Responses and Interpretation of Responses. In the Summary subsection, information gathered from interviews and drafts is presented separately under the three different groups of Indian science writers according to the following categories: Planning, Writing and Revising; Language of Thought; Peer Review and Feedback; and Use of Reference Material. In the Interpretation section, the implications of the findings are discussed under the following categories: Planning; Language of Thought; Sionis' "Message Adjustment Strategies"; Sionis' "Resource Expansion Strategies"; Peer Review and Feedback; and Reading and Using Reference Material. The comments of the Native-Speaking Faculty will be incorporated at appropriate places.

Good planning is considered an important writing strategy by all respondents. Although some respondents still think in their native languages, all write in English. Learning to use mathematical language and reading published literature to enhance language skills are viewed as desirable objectives by all beginner writers. Most feedback comes from advisors; informal peer review among colleagues is uncommon.

Summary of Responses

Indigenous Writers (Group I)

Planning, Writing, and Revising. Although respondents described a writing process typical of most writers, all emphasized the importance of planning. Out of the eight members in this group, five of whom are dissertation writers, all begin with some sort of an outline and "jotting down of points." Since most of these writers are involved with some form of experimental research, they also use laboratory notes in the initial planning.
Although a literature review precedes writing, almost all of these dissertation writers continue with a literature review simultaneously with writing. Anomalies, aberrations, or "known gaps" in the literature search help these writers to plan and organize their writing, especially in the Introduction and Discussion sections. The writing process is recursive since writers constantly revise and rewrite. Typically, these beginner writers compose three to four drafts before submitting them to their supervisor for comments. While in some research institutes and laboratories supervisors intervene before the student has written substantial amounts of his dissertation, in most others supervisors prefer viewing the completed form of the dissertation, thereby involving extensive rewrites and revisions. In one institute, where publication of five articles in refereed journals is mandatory before submitting the dissertation, two of the dissertation writers (belonging to this particular institute) suggested that their dissertations were organized according to the recommended format of the journal(s) in which they hoped to be published. Two out of five of these dissertation writers suggested that while economy of space was very important in a scientific article, a dissertation had a much wider canvas where explanations could be worked out in more detail. Four out of the five dissertation writers indicated that they spent considerable time planning their dissertations before starting to write.

The three skilled writers in this group also described a recursive writing process. Much time seems to be spent on tabulating charts, figures and equations. All three of these writers indicated that they commenced writing only when they could "visualize" the outline of their paper, indicating significant planning.
Language of Thought. All eight members in this group, while in the process of writing, think in their native language but write in English. None write in their native languages and subsequently translate into English. Only two out of the five dissertation writers said that they used the dictionary to check either spellings or locate equivalent words and terms in the English language.

Of the three skilled writers, two used the dictionary: one to check spellings, and the other to interpret reviewers’ comments (e.g. “opaque” style).

Peer Review and Feedback. Informal peer review of rough drafts among colleagues, as a necessary part of the writing process, does not seem to be encouraged among dissertation-writing respondents in India. Although there may be informal discussions amongst immediate colleagues, it is considered “too competitive” to risk a full-scale peer review of drafts. Most feedback, thus, comes from the supervisor. Review comments from supervisors for beginner writers generally include comments such as “not necessary,” deletions, “repetition,” comments on organizational changes (“put this on next page” etc.), “more reference,” clarification and explanations of “missing steps” (which may be identified as Sionis’ “message reduction” strategy), and some amount of rewriting by the supervisor. In some cases, when these beginner writers participate in collaborative writing with the supervisor, the supervisor does the final editing and revising.

Amongst the skilled writers, however, there seems to be a greater degree of informal peer review, and one writer suggested that critiquing other people’s work makes him a better writer. Most of these writers suggested that as dissertation writers, however,
their only source of feedback had been their supervisors. Review comments from supervisors included critiques of grammar, organization, spelling and technical content. Review comments from refereed journals on a more formal scale (from the anonymous review process) on drafts of journal articles include comments on mostly technical content. One writer, who has had a few collaborative publications, suggested that while he found European co-authors “dictatorial,” his American co-author was “terse” pointing to the negotiating process between the writer and his larger community of peers.

Use of Reference Material. While all respondents read published literature to keep up with recent research, some novice respondents use published literature also to improve language skills. All five of the dissertation writers in this group suggested that gaining access to adequate reference materials was difficult in India. Most journals were outdated, and recently published books were difficult to come by. Only two writers suggested that they had access to online databases. The process of storing and retrieving information from literature varied but usually involved underlining and making marginal notes against salient points in xeroxed copies. One writer suggested that she “lifted” (Shaw’s term indicating verbatim copying) useful terms, phrases, or even sentences and incorporated them into her writing. Two suggested that they always write in their own words. One suggested that his writing consisted of quotes and “useful phrases” that he borrowed from published sources. The fifth writer said that although she sometimes “coined” useful words from the writings of established writers, she always paraphrased significant sections/explanations in her own words in order to better understand the phenomenon. Overall, such strategies are adopted when writers attempt to explain a
phenomenon, concept, or behavior, or review existing research in their own review of literature. Such strategies also seem to stem from a basic lack of confidence in their command of the English language and a felt belief that, as one writer explained, "It's so extraordinarily well-written that I couldn't possibly write like that."

One out of three skilled writers suggested that he sometimes borrowed "useful" terms and phrases from published material and explained that he only borrowed terms that he could "assimilate" (e.g. substitute "replace" with "demise").

**Old and New Immigrants (Group II)**

**Planning, Writing and Revising.** While novice respondents describe learning strategies that enable them to write in a professional manner, skilled writers emphasized the importance of planning. All six dissertation writers in this group, like their counterparts in Indigenous Writers (Group I), begin by "jotting down points" and an outline. While one beginner writer indicated that she faced text-based problems (such as synthesizing material from the literature review), she is learning to overcome such problems by focusing and elaborating on one point at a time. "In India, there was no emphasis on writing – they value what you know more than what you put on paper," said the same writer. A second writer, who has just begun writing her dissertation, has to make adjustments to fulfill a different set of audience expectations and "a different way of constructing sentences" by adopting a more critical approach. A third writer, who has just finished writing his dissertation, said that although he began with an outline, he "constantly moved back and forth," thereby revising his goals while writing. The same writer said that while his revision process included tightening sentence structure,
technical content, and organization, he learned to give a "mathematical slant" by inserting more equations in his writing. A fourth said that he learnt to contour his writing according to different audience needs, and that his revision process included editing of word- and sentence-level structures such as vocabulary and transformation of sentences. A fifth writer, who has also just finished writing his dissertation suggested that he felt he had become a better writer after coming to the USA: "I was a sloppy writer before; my writing is much more logical and crisp now." According to him, his writing is more organized and analytical. Like another dissertation writer in this group, he has also learned to use more mathematical language in his writing. One significant way by which he learned to write differently was by studying the writing strategies of skilled writers due to the easy availability of research materials: "I'm awed by the writing skill of some researchers in my area." Two other writers also suggested that reading and studying models in the form of published dissertations and scientific articles helped them in their writing. Two writers who have had some experience in publishing journal articles as dissertation writers in the USA said that since economy of space was far more important in articles than in dissertations, they used different strategies.

Two writers who are no longer beginner writers but are still in the process of socializing themselves describe a different kind of awareness in relation to writing. One starts by writing whatever comes to mind in the logical sequence of events for the first ten to fifteen pages. His revision process is initially focused on organization, then on tightening up of grammar and mechanics. In contrast, the second of these two writers suggested that although he has a general "picture" of his article in his mind, he begins by
a "cut and paste" method where previously written material is reorganized to create the appropriate rhetorical context for a new paper. Such strategies are usually reserved for the Introduction. The development of the paper is then organized around certain central charts, figures and equations. One writer suggested that studying "models" helped in learning to apply theories to engineering problems. While one writer converted four scientific articles into a dissertation, the other writer suggested that he found the dissertation and scientific article very different in purpose and structure. "In a scientific article, a lot of steps were omitted. The justification was just hinted at. In a dissertation there was more scope for elaboration and explanation," explained this same writer.

The five remaining members who are very skilled writers describe varied writing strategies that perhaps enabled them to effectively socialize themselves into their discipline-specific discourse communities. Most of these writers spend considerable time in meticulous planning before the writing process is started. One writer suggested that he "scribbles" handwritten notes, works out the mathematical calculations, and lists a chain of thoughts at random in the first stage. In the second stage, he works out the "connections" amongst these. The initial planning stage is the most difficult part in writing for him. "Proposals and papers are planned differently, but, in general, my writing has become more condensed, and I use more charts than before" said the same writer. The second writer builds his text around a set of ten to fifteen pages of charts, illustrations and tables. "Organization" is thus "easy" because selection of textual material is almost predetermined by the charts and tables. However, each paper is "different" according to this writer. He also suggested that he found it useful to begin with the
presentation of the Results. A third writer suggested that he invested considerable time in building up a “strong literature review” before he started to write. He also emphasized the differences in audience expectations while writing a book, scientific article or a proposal. According to him, writing is an “evolutionary process” and doing it well comes with practice. Initially, although he had problems with tense, over the years he has built up his vocabulary, learned the rules of better rhetorical organization, acquired general linguistic competence and clarity in expression, and learned the rule of “repetition” to signify emphasis. The fourth writer suggested that he, too, spent considerable time on working out charts, tables, and figures, and that in fact the entire text was built around these central graphics. According to him, more time is spent on planning and interpreting the equations and graphs than on writing (“prose is supplemental”). Over the years, “my writing has changed. It is less wordy,” he suggested. The revision process for this writer includes rearranging points and tightening sentences. The fifth writer begins writing by randomly writing: “since I work with theories, I put my thoughts down on paper as soon as they come to my head, but the writing goes through several revisions.” This writer, who changed his major area of specialization after his arrival in the USA, suggested that some things that he had to learn in order to write well included organization, integration of text with formulae, conventional American punctuation rules, and formatting techniques.

Language of Thought. Although all respondents write in English, they think in English, their native languages, or in a mix of both. Five out of six of these dissertation writers said that they thought in English while writing. All of them suggested that they write
entirely in English and do not revert back to using native language when they are unable to find exact equivalents in the English language.

While one of the two near-skilled writers suggested that he thought in English, the other suggested that although he always thinks in his native language and sometimes even writes the initial problem-definition stage in his native tongue (and later translates it into English), in recent times he is beginning to think in English.

Most of the remaining five very skilled writers suggested that initially as graduate students they used to think in their native languages, but years of stay in the USA and concomitant participation in the knowledge-making process in science through publications in refereed journals and of books have not only changed how they think before they write but also the language of their thought. As one very skilled writer suggested, “the scientific vocabulary or stock of words is not very large. You have a very limited number of words. Inevitably, thus, you begin to think in the language that you are writing in.” But, for some of them, the initial planning, including the basic structuring of the equational/mathematical framework, is worked out in their native languages. Two writers suggested that when exact English equivalents did not come to mind, they wrote the word down “phonetically” to be checked later in the dictionary or wrote it in their native languages to be replaced later with an English word. A third said that he always kept a thesaurus handy. Only one suggested that since he went to an “English-medium” school, it has been always easier for him to think in English. (For information on the schooling of respondents, please see Appendix C.)
Peer Review and Feedback. According to respondents, informal peer review among colleagues in India and the USA is rare. While novice writers get feedback from their advisors, skilled writers receive feedback from the formal process of blind review. Almost none of the writers in this group had any experience in informal peer review in India. As a beginner writer in Indigenous Writers (Group I) had suggested, the atmosphere was too "competitive" to practice informal peer review among colleagues. "In India everybody thinks that they know better English than most people," suggested one dissertation writer who is now in the USA, as a consequence of which students found themselves working in isolation. In the USA, although there are some informal discussions, only one of the six dissertation writers suggested that he benefitted from informal peer review. For nearly all of them, feedback came from immediate supervisors. Almost all comments on dissertation drafts involved changing organization, rewriting of sentence structure, clarifying technical content, and removing ambiguity. In a few drafts, comments such as "more references" suggested that some additional information needed to be incorporated.

Interestingly, one of the two near-skilled writers said that since his advisor in India was trained in the USA, the nature and kind of feedback that he received in India from him was similar to what he received in the USA. Advisorial feedback in the USA was, however, more up-to-date. For the other writer, feedback came from the co-author on a collaborative project in the form of recommended changes in rhetorical organization, incorporation of additional technical information (message reduction), use of the article system, and format changes.
All five skilled writers said that as dissertation writers they received feedback only from their advisors in the USA. Usually, advisory feedback included comments on organization and grammar. As skilled writers, however, while three indicated that they did not benefit from any kind of informal peer review among colleagues in the USA due to a lack of time and the unavailability of a specialized audience, two said that they benefitted from informal discussions with their immediate colleagues, both in India and the USA. Most feedback for these skilled writers comes from the formal process of anonymous review. Two of these writers said that they disliked collaborating on multi-authored articles due to differences in writing styles and conventions. One writer, who has published extensively, said that he found that co-authoring with European writers required a different set of conventions (sentence structure, vocabulary and organization). As a reviewer, he generally finds Indian scientific writing characterized by grammatical inaccuracy, lack of coherence, and transition problems. A third writer said that the nature of review comments from refereed journals on his articles varied: some published as is, some with minor revisions, and some with major revisions. Although the bulk of the comments are directed towards technical content, some refer to his habitual use of long sentences and use of the present tense. A fourth writer suggested that although most of his review comments were directed towards technical content, some were directed towards rhetorical organization.

Use of Reference Material. All writers in this group agreed that research material was far more readily available in the USA, and that part of the socializing process included keeping oneself up to date with research. One dissertation writer suggested that she used
reference material not only by noting salient points, but also by taking note of “useful phrases” or examples of “good English” (e.g. “agglomerate” instead of “collection,” or phrases such as “in confirmation with this result …”). Such strategies are found useful for making writing more emphatic and clearer. Two dissertation writers suggested that they generally do not copy the literature reviews, but rather read published literature several times to remember the salient points. The fifth writer suggested that while referencing research material in texts, he occasionally used direct quotations. A sixth said that although she usually rephrased citations in her own words, she sometimes used the language of published material. The two near-skilled writers adopt similar practices.

Of the five skilled writers, three suggested that they kept track of current research activities by extensive reading and occasional underlining of interesting facts in copies of journal articles. A fourth suggested that he made a synopsis of the interesting trends in his literature review and adapted these to suit the differing rhetorical needs of his articles. A fifth writer suggested that his literature review process was almost continuous, but generally, for any specific article, it started almost five years ahead of time. Use of reference material was made by taking a note of not only matters of scientific interest, but also of “useful phrases.” This writer also said that although he believed that one’s writing style was a product of one’s reading and writing habits and cultural exposure, there is a tendency to be influenced by the style of a particularly well-written article. In general, this writer found that “writing in the USA was more coherent and methodical.” All five suggested that initially, as graduate students in the USA, looking at models in terms of published dissertations and journal articles helped. For most of these very skilled writers,
these initial models "were something to look at – to see what others had done." As one writer pointed out, "Initially, there was a blind acceptance of what I read and heard, but now I’m more critical.” All of these writers suggested that although precision was important in both the dissertation and the scientific journal article, the former enabled more detailed explanation. The scientific article is concise, addressed to a specialized audience, and involves reconfirmation, refutation or an extension of existing work.

**Foreign-Returned (Group III)**

**Planning, Writing, and Revising.** Like the skilled writers in the previous group, the seven members of this group emphasized the importance of planning. All begin with an outline, where relevant points are organized in a sequential pattern. A common characteristic of these skilled writers seems to be that all have a fairly well-defined idea of what they are going to write, and what the final paper is going to be like. The words of some of these writers such as "I have a geometric view of my paper," or "I need to have a vision or a picture of the paper in its totality" indicate that these writers have a visual model of what they are planning to write. For one writer, who goes through multiple handwritten drafts, the focus of concentration is on explaining a phenomenon, and matching it with appropriate computation and experimental work. A part of this also involves integrating the text with the necessary charts, tables, and figures. "I spend some time on getting a precise, definite and accurate description," said the same writer. Another writer allowed his students to critique his paper, thereby enabling them to acquire some notions of organizing a paper. According to him, “I’m a better writer now. I used to have tunnel vision. Now I’m more persuasive, less aggressive – more ready to accept valid
alternatives.” Good scientific writing, according to him, is based on rigor and organization. A third writer suggested that scientific academic writing and popular scientific writing were very different: “In academic writing there is no room for ambivalence or digression. Precision is very important.” Writing and revising are a simultaneous process for this writer. Another writer indicated that his writing approach was determined by the nature of the subject. While in a review article, the approach was interdisciplinary, in an “original” scientific paper, the focus was on the methodology. In a research book, all writing skills are devoted towards persuading the scientific community to arrive at a consensus. This writer suggested that his strategy was to write according to a specified format: “I structure writing under different headings to suit different purposes.” A sixth writer suggested that he initially begins with “pencil-scribbling,” and like the previous writer, writes according to a predetermined format. “I begin with a list of points, but this changes as I write along.” Meticulousness in writing, according to this writer, is an important attribute that pays in the “long run.” The seventh suggested that he writes according to subsections and makes use of copious laboratory notes taken, sometimes, over a period of three to four years. This writer finds it easy to dictate, and sometimes starts writing afresh when “big gaps” are identified while composing.

Language of Thought. Only one writer suggested that he thinks in English while composing. All others indicated that they think either entirely in their native language or in a mix of native language and English.

Peer Review and Feedback. Most of these writers suggested that opportunities for conducting informal peer review in India were sparse. A few however, suggested that
sometimes immediate colleagues provided some informal feedback which pertained to recommended changes in organization or incorporation of justificatory material. Since almost all of these writers had earned their highest degree in the USA or Europe, they had benefitted from feedback from their dissertation advisors. As graduate students, they had received comments pertaining to organizational and grammatical changes. As faculty members in India, they actively encourage informal critiquing of writing amongst their students. One writer suggested some of the most stimulating feedback came from his junior colleagues. All except one agreed that opportunities for informal discussion with colleagues were more frequent in the western countries. Like their counterparts in the previous group, these skilled writers receive feedback from the more formal process of anonymous review.

**Use of Reference Material.** Only three out of these seven writers suggested that they made notes on current literature reviews, one of whom used short summaries of important articles. The rest indicated that they only read scientific journals to keep up with current research. All agreed that recent scientific information was not easily available in India. All suggested that while the dissertation emphasized continuity of work and original contribution, it was written for a different purpose and audience in comparison to a scientific article. A scientific article always contained something "new," was more persuasive, and more compact.
Interpretation of Responses

Planning

The literature review suggests that all scientists and engineers invest considerable time planning (Latour and Woolgar 1979; Selzer 1983; Parkhurst 1990). Analyses of the responses outlined above likewise indicate that outlining and planning before starting to write are significant factors for all writers in this study. The strong emphasis on the need to "visualize and plan meticulously" to ensure precision in writing becomes more evident as we move from beginner to skilled writers in this study. Although the initial goals and the drafts undergo several revisions, describing a "recursive process," the need to write according to a predetermined outline is clearly considered important by all writers.

The interview responses of the skilled Indian science writers indicate that since they have already mastered the skill of rhetorical structuring, the major part of their planning activities are devoted towards organizing tables, charts, equations, and figures. Since many of them submit articles to a variety of journals, much restructuring is done to adapt to the varying needs and interests of the different journals. The slight differences in planning strategies (see Summary) are also indicative of the writers' attempts to adapt material according to the needs of their specific disciplines.

Beginner writers in this study on the other hand, describe a variety of planning strategies that indicate that the major part of all planning activities is devoted to fundamental structuring of the IMRAD format and incorporation of the literature review at the appropriate places. Such planning strategies reveal that these beginner writers are
learning to respond and contour their writing to the genre-specific requirements of their discourse communities, including beginning with the sections that are easiest to write.

Interestingly, however, Parkhurst's (1990) comparative study between the writing processes of native and nonnative science writers reports that native science writers do not have "this elaborate mental model." This suggests that although all science writers plan to some extent, nonnative writers engage in more planning. Studies by Shaw (1991) and St. John (1987) confirm that other nonnative science writers also attach significant importance to planning. According to the skilled Indian writers in this study, good planning is something more than a good organization and an arrangement of ideas. It arises from a fundamental grasp of research material, objective, and methodology.

According to a skilled writer in Old and New Immigrants (Group II), most of the writing problems that Indian beginner writers face in the USA arise from an inability to generate an "overall picture" in the mind due to a weak conceptual understanding of the research process.

Language of Thought

Although Shaw (1991) and Sions (1995) report that some of their nonnative science writers write bilingual drafts (to be later translated into English with the help of others), all interviewees for the present study indicated that they wrote entirely in English. The dictionary is used infrequently, mainly to check spellings, to look for synonyms, and sometimes to look for meanings. This sporadic usage could perhaps be due to the fact that since English is taught either as first or second language in most Indian schools, Indian writers do not need it quite as much as some other nonnative writers do.
Interestingly, however, almost all writers in Indigenous Writers (Group I) suggested that they thought in their native languages while planning and thinking. Only two dissertation writers in Old and New Immigrants (Group II) suggested that they did the same; the rest suggested that they had switched to thinking in English. Most of the skilled writers in Old and New Immigrants (Group II) and Foreign-Returned (Group III) suggested they thought in a “mix” of English and their native languages, with two suggesting that they thought entirely in English. The switch to gradually thinking in English (Group II members) may perhaps have something to do with the fact that these writers are now writing in a more naturally English-speaking environment. The language of thought processes seems also to be often determined by factors such as whether the writer went to a vernacular or English-medium school in India, the duration of stay in the USA, and age. For instance, the older generation of writers who gained high school instruction in their native languages find it easier to think in their native languages.

Sionis’ “Message Adjustment” Strategies

Claude Sionis (1995), in his study of the communication strategies adopted by French researchers writing in English, identifies certain characteristics in nonnative science writing that arise due to an inadequate grasp of the English language. Sionis calls them “risk avoidance” strategies and classifies them as “Topic Avoidance” (“missing steps”), “Semantic Avoidance” (“ambiguous construction”) and “Message Reduction” (“incomplete information due to excessive reduction and simplification of messages”) (105-106). Although Sionis’ classification system is somewhat overlapping, it is a useful way of determining ambiguities in nonnative science writing. We have already identified
the desire to write with clarity as an on-going concern for all writers in the present study. The large number of handwritten additions made by advisors in dissertation drafts in Indigenous Writers (Group I) indicate that beginner Indian science writers face a little of all of these problems. (Please see “Rhetorical and Organizational Changes.”) Advisorial comments on dissertation drafts written by graduate students in Indigenous Writers (Group I) such as “more reference here,” “not clear,” and “how” would indicate that ambiguities in such writing arise from either eschewing necessary steps or from condensing/reducing/simplifying information. It may be recalled that beginner Indian science writers tend to have problems with transitions. (See section on “Grammar, Language and Vocabulary-Related Concerns.”) Four out of five Native-Speaking Faculty (Group IV) indicated that ambiguities in the drafts of some of their Indian graduate students often arose from a lack of “in-depth discussion” or inadequate explanation. As one native-speaking faculty member pointed out, “This sometimes happens when you know too much ... the need to explain and clarify is overlooked.” Considerable rewriting by advisors in dissertation drafts in India would indicate that some amount of “message reduction” is occurring in the initial drafts written by these students. Conversely, the substantial amount of deletions (“not necessary,” “delete”) in the drafts of dissertation writers in India would indicate that beginner science writers perhaps also err the other way around. As one skilled writer in Group II suggested, “When I was writing my thesis for the first time in the USA, I tried explaining everything in order to remove ambiguity ... and thus ended up with a lot of repetitions.”
Sionis' "Resource Expansion Strategies"

In his study (1995), Sionis identifies "Resource Expansion Strategies" as "compensatory strategies" that nonnative writers in science frequently adopt to obviate the need to write in general prose. One of these is characterized by an overuse of "mathematical language," graphs, tables and charts. Analyses of the interview responses indicate that all Indian science writers adopt this "facts-and-figures-can-speak-for-themselves" attitude. While the responses of the beginner writers in Indigenous Writers and Old and New Immigrants (Groups I and II) indicate that they would like to write in a way that is marked by equations, graphs, and charts, those amongst these who feel that they have learnt to write well after coming to the USA suggest that they learned to give a "mathematical slant" to their writing. Some of the skilled writers in Old and New Immigrants and Foreign-returned (Groups II and III) consider equations, charts, tables, and figures as central to their writing: "Prose is supplemental and is used to integrate or interpret the figures." In fact, as we have seen earlier, a good deal of planning activity for some skilled writers is devoted to organizing equations, graphs, and charts.

Although such strategies can be partially explained by the fact that certain disciplines such as Computer Science, Statistics and some branches in engineering require the use of mathematical models, it is quite possible that Indian science writers tend to overuse them. In the review comments on the drafts of two scientific articles (one written by a graduate student in India and the other by a skilled writer in the USA), suggestions are made that a lesser number of charts and tables would be desirable. Three out of the five Native-Speaking Faculty (Group IV) indicated that some of their Indian graduate
students used more equations, charts, and tables than their native speaking graduate students. Sionis suggests that this over-reliance on mathematical formulae arises from a belief that the mathematical formula is the “best and indisputable form of conclusion” (110). He also suggests that an overuse of this strategy prevents writers from developing “new language skills.” Sionis reports that the only sections in a scientific paper that are not characterized by mathematical language are the Introduction and the Final Conclusion. It may be worthwhile to recollect that most beginner and some skilled Indian science writers find the Introduction difficult to write. (See “Rhetorical and Organizational Changes,” Ch IV.) Jenkins et al. (1993), however, suggest that the notion of the role of writing in some science and engineering disciplines was construed to be a sort of “glue” that holds equations together. Despite the fact that such “resource expansion” strategies may not be so desirable, replacing general prose with mathematical language does seem to be a “successful” strategy in the socialization process, as evinced by the large number of publications by the skilled writers interviewed for this study.

Reading and Using Reference Material

It has already been indicated in earlier sections that reading of published literature is construed as an important strategy in the socialization process that enables beginner Indian science writers to write better. Most skilled writers also seemed to think that in order to write in an acceptable manner, beginner writers need to “steep” themselves in reading. The enhanced research environments and library facilities in American universities provide ample opportunities for beginner writers to keep up with current research and study the various writing strategies that the more skilled writers employ.
While novice dissertation writers are still familiarizing themselves with the structure and content of the IMRAD format, the more skilled writers, some of whom have been completely socialized into western discourse communities, are in the comfortable position of making statements such as “When I first came here as a graduate student, I tended to accept everything I read .... Now I write what I want to.” This tallies well with Bazerman’s assumption based on the Vygotskyan principle that neophyte members are gradually inducted into particular discourse communities as they learn to speak and write like their more skilled and experienced peers. Parkhurst’s (1990) observation that both native and nonnative science writers deemed “extensive practice in reading” as being helpful in learning to write well would indicate that this belief is not restricted to nonnative speakers.

Although the means of storing and retrieving information varies, most beginner writers tend to make copies of journal articles and read them several times. Although some skilled writers continue to do the same, many of these skilled writers in Old and New Immigrants and Foreign-Returned (Groups II and III) keep themselves up to date by merely reading recent research.

However, published literature is also used to improve language skills. With the exception of a few writers, most beginner writers and one skilled writer in this study suggested that they borrowed “useful terms and phrases” from published sources and incorporated them in their own writing. As one beginner writer in Indigenous Writers (Group I) explained, this strategy is helpful in the Introduction, Literature Review and the Conclusion. Another suggested that it was most useful in explaining a phenomenon. For
most of the times, terms and useful phrases are "lifted" (Shaw's term) for improved vocabulary, and sometimes, in the words of a dissertation writer interviewed for this study because "It's so well-written – it's explained so well, that it's difficult not to be influenced by the writing style of this author." Although most of the time the sources are acknowledged scrupulously, this writing strategy is perhaps used to compensate for a perceived inadequacy in linguistic expression. As one skilled writer in Group I pointed out, "Traditionally it has been important to write well in India because of our colonial past. In order to be accepted, you have to speak and write good English." I would also like to suggest that the tendency to over-quote (in some dissertation drafts in Indigenous Writers, Group I) can also be interpreted as an extension of the same strategy. Studies by Shaw (1991), Parkhurst (1990), and St. John (1987) suggest that the strategy of borrowing words from published literature is also practiced by other nonnative writers. However, Selzer's (1983) study of the writing process of a native-speaking engineer confirms that such strategies are not restricted to nonnative writers.

It is not difficult to imagine why some beginner writers interviewed for this study are greatly influenced by the "good English" of skilled writers. Barring a few exceptions, most beginner writers graduating from typical Indian universities are more used to the "reproductive" and text-based mode of learning emphasizing rote and imitation. Viewed against this context, borrowing words and later "assimilating" them (e.g. "simulation" replaced with "emulation" or "agglomerate" instead of "collection") appear to be a learning strategy in the socialization process not only in terms of learning new words but also in relation to learning new ways of framing an argument and establishing an evidence.
within the text. Pennycook (1996), while analyzing the textual borrowings of Chinese students, however, suggests that “all language learning is to some extent a process of borrowing others’ words” and in cases of second language learning is associated with memorization of words from the text. He goes on to caution that since notions of textual ownership and authorship are essentially western “cultural and historical” concepts, we should without compromising “academic standards” make room for “flexibility” while evaluating such practices of textual borrowings in the writings of people from different cultures (227).

Peer Review and Feedback

As explained in Chapter III, informal peer review can be viewed as an important socializing factor for science writers. The academic environment in India is such that opportunities for conducting informal peer review among colleagues are rare. Since graduate students working under the same dissertation advisor tend to work on the same or related projects, there is, however, evidence of some informal interaction amongst immediate colleagues in India. Since the environment is fundamentally competitive, these interactions, consisting of reading first drafts, are restricted to “close friends.” Most feedback thus comes from immediate advisors pertaining to recommended changes in organization, grammar, and incorporation or deletion of scientific information at appropriate places. Requests for clarification are also common. Beginner writers who come to the USA as graduate students are thus not entirely familiar with the phenomenon of informal peer review. Like their counterparts in India, these writers too obtain most of their feedback from their immediate advisors. Most comments pertain to
improving organization, grammar, clarity, and incorporation/deletion of technical material. The fact that informal peer review does not seem to be popular makes one wonder whether in the Indian context, such instances can be interpreted as an extension of the authoritarian system where the advisor’s word is greatly relied upon.

Considering the fact that knowledge-making in science is communal in nature, it is surprising that informal peer review does not seem to be common amongst skilled Indian writers in the USA. As one writer pointed out, lack of opportunity, time, and a specialized audience does not make it feasible. Most feedback for these skilled writers arrives from co-authors (in collaborative endeavors) and from the more formal process of anonymous review. Although Shaw (1991) suggests that for some of his nonnative writers, “integration” with other researchers both within and outside the department facilitates the process of socialization, some nonnative writers feel constrained by their selection of research areas and language problems.

Parkhurst (1990) reported that skilled nonnative science writers residing outside the USA tend to get less feedback, and those that live within the USA get less than their native counterparts. She also suggests that while nonnative writers get more feedback in the form of corrected sentence-level errors, native writers get more “marginal” comments and “rewrites” with accompanying explanations. This is at odds with my observation, which suggests that skilled Indian science writers also tend to get deletions/additions/rewrites with some sort of an explanatory comment in the margin. Skilled respondents write “rebuttals” indicating that as fully socialized members they negotiate with their larger community of peers in the knowledge-making process in science. Although such
formal interactions with the outer community of peers may partly facilitate the socialization process, the single most contributory factor in the socialization process of beginner Indian science writers in the USA, as the interview responses show, come from interactions with advisors and supervisors at the dissertation stage.

**SUMMARY OF FINDINGS**

**Cultural, Rhetorical and Writing Contrasts**

Indian graduate students who come to the USA reveal a range of writing proficiencies in as much as they are products of their cultural, economic and educational backgrounds in India. Although English is a compulsory subject in all states at some stage or the other during the school years, the peculiarities of the language policy changes in independent India has eroded its primary position in the educational system in India. While some states continue to encourage the instruction of English in the lower grades, others start instruction at the middle-school level. The existence of vernacular schools and elite public/convent schools, with the latter strongly focusing pedagogical strategies on learning to speak and write well in English and the former encouraging the use of native Indian languages, further intensifies the differing English-language skills between those graduating from vernacular schools and those from convent schools. The authoritarian mode of imparting education with its reliance on text-based instruction and emphasis on the word of the teacher ignores the development of argumentative and critical faculties in students. The tradition of writing instruction in English, such as it exists, is conducted through the study of British literary texts, with little focus on improving functional English. As indicated, the combination of such factors can be disadvantageous for some
beginner writers who attempt to socialize themselves into western scientific discourse communities.

**Rhetorical and Organizational Changes**

In spite of the fact that most Indian students at the school level and some at the collegiate level generate a good bit of writing through answering standard essay-type questions, the propensity of examiners to test students on their abilities to recall text-based material and lecture notes makes such writing predominantly descriptive and narrative. Such examination-taking strategies can prevent students from developing critical and argumentative skills, or worse, from establishing an independent point of view. Most beginner Indian science respondents in their first attempts to write a dissertation or a journal article find the markedly rhetorical aspects of the traditional IMRAD format difficult to write. Typically, as we have seen, these difficult sections include the Introduction, Discussion, and occasionally the Conclusion sections. Although the root causes might be different, that such problems are common to other nonnative writers are documented by Parkhurst (1990), St.John (1987), Swales (1990), Hill et al. (1982), Shaw(1991), Gosden(1995), Sionis (1995), Fox (1994) and beginner native writers by Swales (1990), Shaw (1991) and Casanave and Hubbard (1992).

Interview responses of both beginner and skilled writers in this study indicate a strong correlation between perceived difficulties in writing the rhetorically complex Introduction and Discussion sections and the beginner Indian science writer’s initial difficulties/unfamiliarity in adopting a “point of view” or “voice” (if I apply Cadman’s terms to the Indian context) in developing and organizing a cogent argument or a critical
synthesis. The Methods section, which is mostly narrative, is not an obstacle. The Introduction and the Discussion sections, with their emphases on substantiation, justification, and clarification, rely on rhetorical skills such as abilities to persuade, argue and infer based on a critical review of facts and figures. Since knowledge-making in science is cumulative and consensual, presenting data that will forcefully establish the need, significance, and rationale of the current research, is considered crucially important. Socialization into western discourse communities necessitates a complete change from the traditional Indian authoritarian mode to a more individualistic form of self-expression on the part of these fledgling writers.

Novice Indian graduate students recently arrived in the USA find it difficult to select and weave in citations at appropriate junctures, leading to problems while structuring their argumentation. An excessive reliance on the textbook method perhaps also explains the propensity to quote verbatim (sometimes quite extensively) from published literature while writing the Introduction, Discussion, or the Review of Literature sections.

Problems such as including repetitious and redundant material in organizing writing according to the IMRAD format also arise from the Indian cultural preference for providing an appropriate “background” which is at odds with the western ideal of “getting to the point.” The fact that the tradition of writing instruction in English in India has had a strongly literary bias without the benefit of any well-defined program for scientific writing also explains to a certain extent the sense of digression in beginner Indian academic discourse.
Grammar, Language and Vocabulary-Related Concerns

Although some writing problems are common to other groups of nonnative speakers and could be even common to some native speakers (Shaw 1991; Parkhurst 1990; Ventola 1992; James 1984; St. John 1987; and Tucker 1995), typical problems that beginner Indian science writers face include a tendency towards writing long and convoluted sentences which results in occasional errors in tense usage, transition, and cohesion. The tendency to use too many qualifiers in single long sentences often results in heavy nominalizations, leaving ample opportunities for grammar-related errors to creep in. The most common problem is the inappropriate switching between the present/past tenses, the active/passive voices, and singular/plural. Another oft-stated problem leading to flaws in the "thematic progression" (to use Ventola's term in connection with scientific writing with Finnish writers) in texts is the inadequate use of cohesion reference markers in sentences such as "a," "an," "they," "these," and "it." "Functional incoherence" (James' term) also arises from a failure to demarcate clearly or establish the linking between switches to and from the description, analysis and explanation modes in text. Interview responses would indicate that while the failure to use reference markers such as "they/"that"/"it" might be due to occasional slips of the pen while writing in a hurry, errors related to the use of the article system in English such as the overuse or underuse of "a"/"an" are often characteristic of novice Indian writers.

The older generation of Indian science writers, most of whom are extremely skilled writers (if publication records are anything to go by), feels that the younger generation of Indian science writers is more apt to make such errors perhaps as a direct consequence of
language policy changes in English language instruction in India. Interview responses also indicate that both skilled and beginner writers feel that the remedy that successfully addresses such problems is learning to write short and crisp sentences. The probability of making tense-and cohesion-related errors is considerably reduced, thereby improving readability at the micro and macro levels.

While such grammatical and mechanical errors are viewed as minor yet of irritating nature (and have become, to use Tucker's eloquent phrase, "fossilized errors"), most beginner writers are concerned with writing that is clear and free from ambivalence. The peculiar emphasis on or importance of "scientific clarity" is understandable given that a scientist's primary objective while reporting results and making claims is to write the methodology not only to establish their scientific validity but also to allow for "replicability." While in some cases, attempts at achieving clarity drive some beginner writers to include repetitious prose (literally, hammer in the stated points!), others seek to improve word-choice and vocabulary. For skilled writers who have mastered rhetorical organization which, however, still persists as a problem in the less skilled writers, finding the most exact form of expression is a matter of continuing concern. While in skilled writers the search for the right word reveals a sophisticated awareness for word-play, in beginner writers it is fostered by a desire to be accepted by their peer community.

**Identification of Typical Writing Strategies**

Planning and outlining before commencing to write is typical of Indian science writers, although the literature review would suggest that it is not uncommon in other nonnative science writers (Parkhurst 1990; Shaw 1991). The need to "visualize and plan
meticulously" as a writing prerequisite becomes more evident as we move across from beginner to skilled Indian science writers. According to skilled respondents, good planning arises from a thorough understanding of the research materials and research objectives.

Unlike other nonnative science writers examined (Shaw 1991; Sionis 1995), none of the Indian science writers in this study suggested that they wrote in their native languages. While respondents in India think in their native languages, those who stay in English-speaking environments have switched to thinking in English.

Certain "Message Adjustment" strategies such as missing steps and ambiguous construction or incomplete information due to excessive reduction and simplification of messages identified by Claude Sionis as being characteristic of French scientists arising due to an inadequate command over the English language are also common in beginner Indian science writing. Advisorial comments and rewriting on dissertation drafts in India indicate that beginner Indian science writers might face a little of all of these problems. That such writing deficiencies are also common in beginner Indian writers in the USA is corroborated by the comments of native-speaking faculty members. Sionis’ classification of "Resource Expansion Strategies" as a compensatory strategy employed by nonnative science writers to obviate the need to write in general prose is also identifiable in Indian science writing. The most common example of this is the excessive use of mathematical language, graphs, tables and charts. Learning to give "a mathematical slant" to writing is viewed as an index of "good" scientific writing by most beginner Indian science writers.
While the phenomenon of informal peer review is uncommon in India due to a felt belief that the research environment is far too “competitive” for any meaningful interaction to take place, it is not widely practiced among the skilled Indian respondents in the USA due to a lack of opportunity. While most feedback for the skilled writers comes from the more formal process of blind review, beginner writers obtain feedback from advisors. Despite these apparent constraints, feedback plays a significant role in the acculturation process whereby Indian science writers learn to use language that is acceptable to their discourse communities.

Reading published literature is construed as an important strategy to keep up with recent research and improve writing skills. The desire to learn new words and the implicit reliance on textual or published authority perhaps explains why most beginner respondents, like many other nonnative science writers (Shaw 1991; St. John 1987; Tucker 1995 and Pennycook 1996), feel compelled to borrow a list of useful phrases and words (hinted at earlier) from published sources and incorporate them in their own writing. Such a writing strategy is viewed as a “learning strategy” that enables most beginner writers to compensate for a perceived inadequacy in linguistic expression. Since the Indian educational system encourages recall of received knowledge, the Indian beginner writers’ initial unfamiliarity in writing rhetorically persuasive arguments with emphasis on the “voice” so characteristic of the western discourse mode prompt them to quote extensively. In Vygotskian terms such strategies can be interpreted by suggesting that they describe the novice writers’ attempts at learning to assimilate discipline-specific terminology as an obvious step towards socializing into a discourse community.
It is therefore, not hard to understand why most western readers trained to recognize the "point of view" implicit in good rhetorical arguments would sometimes find the organization in novice Indian science writing unclear, characterized, as it is, by inappropriate use of transitions, overuse of quotes, and a faltering sense of the "I." The socialization of the skilled Indian science writers, however, is so complete that such uses of published sources are very rare, and are restricted to a mere reading of the latest journals in an attempt to keep up with recent research.
CHAPTER V

CONCLUSIONS

The main objective of the present research was to identify some of the typical writing problems that beginner Indian science writers such as dissertation writers and younger faculty members in the USA have to overcome to write acceptably within their respective discourse communities. This dissertation has demonstrated that while Indian science writers share many of the problems characteristic of nonnative and native speakers alike, a number of these problems have roots in Indian culture and education, roots which need to be considered when teaching Indians western scientific discourse.

Such research is necessary because of the numerous Indian scientists at home and abroad who are attempting to contribute to the literature of science. As we have seen in Chapter IV, skilled Indian science writers who have acquired their higher training in the USA or UK publish a great deal. Indian science and engineering faculty members studied above, both in India and the USA, have publication records ranging from 40 to 200 published articles, mostly in refereed international journals, although the numbers are somewhat more modest for faculty members who have been trained and continued with their careers entirely in India (18 to 39 journal articles). Nevertheless, despite demonstrated Indian talent for science, the publication culture from which Indian scientists derive little resembles that in the West. India has the second largest "scientific manpower" in the world (Ramani et al. 1988), and certain groups of Indian science writers are actively involved in the knowledge-making process in science by publishing
prodigiously, yet how do we account for the rather dismal statistic of a total of 0.03% of overall scientific publications from India, according to the Science Citation Index? (Gibbs 1995). One possible explanation could be that India is not credited in the Science Citation Index for Indian scientists publishing from abroad (Raghuram and Madhavi, 1995). Since most of the US-trained Indian researchers fall into this category (corresponding to the skilled writers in Old and New Immigrants group in this study), the fraction of researchers who have returned to India and continue to publish is small (corresponding to the Foreign-Returned group in this study). The overall percentage of purely Indian research publication in the international context is therefore low, possibly due to, as Madhavi and Ragahavan (1995) suggest, "high rejection rates."

Consequently, any attempt to understand the writing challenges faced by Indian science writers must consider first their origins in Indian scientific culture. This research has demonstrated that factors such as poor research environment, lack of research facilities, and lack of incentives for publication contribute to the overall low scientific publication rate from India and poor preparation of graduate students arriving in the West. Gibbs (1995) has suggested that a substantial number of research articles submitted for journal publication from Third World countries are rejected due to poor research and poor writing abilities. Yet many Indian science writers who have come to the USA/UK for graduate training are extremely skilled writers and have successfully socialized themselves by learning to "renegotiate their knowledge claims" (Swales' term) effectively for their discourse communities. One interesting phenomenon (Swales 1990 calls it a "difficult question") that emerges in the nonnative-speaking context is the
formation of almost a parallel set of "discourse communities" within a specific language group. On a continuum, thus, we have on the one hand, an "elite" (if I may apply Swales' term in the Indian context) group of foreign-trained Indian researchers who write well and get published equally well, and on the other, beginner Indian science writers who have yet to cross the "rhetorical gap" in order to write in a manner acceptable to their academic peers.

While it is difficult to generalize on the strength of a single study, analysis of the interview responses enables us to identify certain trends that are typical of beginner Indian science writers, although the conclusions derived from this study should not be taken as generalized statements about all Indian science writers. The conclusions are summarized as follows:

1. Initial training in the text-based reproductive and authoritarian mode, combined with a heavy literary emphasis, inhibits the development of critical and rhetorical skills in beginner writers. Such deficiencies are viewed as obstacles towards writing an effective argument or a critical synthesis.

2. Beginner Indian science writers have difficulties in validating claims and inferences in the Introduction, Discussion, and Conclusion sections.

3. Such difficulties arise from a lack of rhetorical awareness of the IMRAD format, including the role of citations as a rhetorical tool.

4. Repetition and flowery, literary language are identified as language-related problems. Cultural traits such as providing background contextual information combined with a lack of scientific writing instruction produce writing that is
imprecise and digressive. Writing shorter sentences is viewed as an effective writing strategy.

5. Unlike other nonnative writers studied to date, Indian science writers write drafts entirely in English.

Other grammatical problems include the ineffective use of tenses, articles, and cohesion. Planning, using mathematical language, and extending vocabulary are identified as successful strategies that are adopted to overcome writing problems. Reading and using advisorial feedback are other strategies that facilitate the socialization process. Informal peer review among colleagues is uncommon.

In spite of the fact that English has been a primary language in India in the last few hundred years, for a variety of historical, cultural and educational reasons, beginner Indian science writers reveal various deficiencies in writing scientific English prose which, although similar to those of other writers, have specific Indian causes. For a few of the beginner writers who have been fortunate enough to study at schools and colleges comparable to those in western countries, the socialization process or crossing the "double cultural shift" is relatively easy, it is true, constituting learning to write in a more professional or discourse-specific manner. Certainly the wide variety of educational and research facilities along with opportunities for informal feedback through interactions with supervisors that are available to these writers once they arrive in the USA bolsters the socialization process for these writers. For the younger faculty members or research associates who have already become familiar with the rudiments of writing according to genre-specific requirements during the dissertation writing stage, further socialization is a
matter of continuing the on-going process of fine-tuning and developing rhetorical skills through reading and writing.

For most beginner writers, however, including those writing their dissertations in India, the "double cultural shift" involves a more holistic appreciation of the rhetorical/persuasive factor lambent in good scientific writing. But more than that, they must learn to disassociate concepts of "good writing" from a mere reproduction of received facts and understand that according to the ideal set by the western discourse model, in order to write well one must develop a "point of view" and acquire the ability to critically synthesize facts from the published literature. These changes require significant mental shifts, for the writers must in a sense unlearn nearly everything they have been taught in India about effective writing. Once the beginner writers achieve these goals at the discourse level, however, recurrent writing problems such as repetition, redundancy, tendency to over quote, inabilities to establish claims, justifications and rhetorically demarcate between the Introduction and the Discussion sections in the IMRAD format can melt away. "Surface-level" problems related to the correct usage of cohesive words and tense can also be dealt with, as the various responses show, by writing shorter sentences which provide little opportunity for inserting too many qualifiers.

It would be presumptuous to imagine that once these writing problems have been identified, acquiring the ability to overcome them is accomplished overnight. The socialization process is slow and gradual, and depending on the cognitive "predisposition" of individual writers, is achieved through extensive reading, studying of "models,"
interactions with advisors, and conscious adoption of "successful" writing strategies. Yet, that these goals are entirely realistic over a span of time is amply illustrated by the publication successes/triumph of the skilled Indian science writers, who, through years of reading and writing in a conducive research environment, such as in the USA, have socialized themselves to such an extent that they are now respected members of their respective scientific communities.

SIGNIFICANCE OF STUDY AND IMPLICATIONS FOR FUTURE RESEARCH

In view of the fact that there has been almost a complete absence of any documentation on the writing behaviors of Indian science writers, the significant contribution of this research lies in establishing some of the writing hurdles that most beginner Indian science writers have to overcome and in identifying some of the strategies that enable them to do that.

While previous studies (Parkhurst 1990; Shaw 1991; Casanave and Hubbard 1992; Fox 1994; Ballard 1984; Tucker 1995) comment on the writing behaviors of nonnative writers in general, the present study identifies and documents the writing problems faced specifically by novice Indian science writers to get published. The data collected in this research provide a means of setting upper and lower bounds to the range of language proficiency skills in Indian science writers. This study also traces the cultural roots of writing problems for Indian-trained graduate students in the USA, even those problems shared with native speakers. By generating such useful data, this study establishes the groundwork for future quantitative research in this area.
The findings of the current research point to the surprising fact that beginner Indian science writers, in spite of receiving formal instruction in English in India, are in many ways not atypical of other nonnative science writers. Some of the writing problems that I detected as being common to beginner Indian science writers are also common among other nonnative writers of non-Indian origin. A few exceptions would be that unlike other nonnative writers (Shaw 1991; Sionis 1995; St. John 1987), beginner Indian science writers write entirely in English, reflecting a greater familiarity with English, which can be probably attributed to the fact that English is taught in most Indian schools. Furthermore, skilled Indian science writers who are completely socialized seem to have overcome such initial writing hurdles that, however, still seem to persist in the skilled Spanish science writers documented in St. John’s study (1987).

It is also tempting to see in what ways beginner Indian science writers differ from novice native-speaking science writers. On the basis of extant literature (Parkhurst 1990; Casanave and Hubbard 1992; Swales 1990; Fox 1994; and Dong 1996) and the comments of the native-speaking faculty interviewed for this research, it is possible to suggest that between beginner Indian science writers and native-speaking writers the differences in organization and rhetorical problems at the discourse level seem slight. Some of the problems that beginner Indian science writers face while organizing their writing (such as the Introduction, Discussion, Conclusion and the integration of citations at appropriate places) are also fairly common in native writers. As Ballard (1984) points out, all “university-level entrants” have problems coping with the demands of academic discourse. However, for beginner Indian writers, learning to write well necessitates
developing argumentative and rhetorical skills. The differences would probably be more distinct in "surface-level" features such as in the beginner Indian science writers' habitual problems with article use and other grammar-related problems arising from writing "overlong" sentences. Indian science writers presumably also indulge in extensive planning before commencing writing to an extent that native science writers do not. Since more research is needed in this area, these impressions on a comparative note should best be treated hypothetically. By using the conclusions of this study as a starting point, future researchers can conduct comparative studies between Indian and native science writers, Indian and other nonnative science writers, or Indian and other Asian science writers.

Most important, much room is also left for conducting research of Indian science writers on a region-specific basis, especially, as we have seen that the status of English and writing instruction related to it differ from region to region. Since the focus of writing instruction in English varies between English-medium convent/public schools and vernacular schools in India, a comparative study on the writing behaviors between those graduating from the former and the latter is also recommended. Keeping in mind the enormously complex mosaic of educational and linguistic diversities in India, any attempt to typify Indian scientific writing in English can be daunting. Nevertheless, this research serves as the first stepping stone towards documenting some general writing problems that typical beginner Indian science writers face in writing dissertations or publishing research articles in refereed journals. Considering the steady rate at which Indian graduate students are enrolling in the science and engineering departments in American universities, it would be prudent to anticipate some of their communication needs.
PEDAGOGY

The general conclusions of the current research imply that beginner Indian science writers would benefit from a pedagogy contoured towards teaching them to develop a "point of view," write critical syntheses of text-based materials, develop an awareness for the rhetorical distinctions inherent in the IMRAD format, and learn the rudiments in rhetorical persuasion, especially in the appropriate use of citations while substantiating and justifying claims. Since scientific writing is genre-based, it is essentially rhetorical. Bazerman (1988) so fittingly said that good scientific writing depends to some extent in making "intelligent" rhetorical choices, so it is in the best interests of novice writers to be aware of the "interactional" rules in scientific writing. It is particularly important to provide Indian graduate students in the USA with instruction on critical and rhetorical skills. Indian graduate students in the science and engineering departments in the USA are not normally required to take freshman level writing courses (provided they pass certain diagnostic tests) which teach their native counterparts the rudiments of argumentation, critical evaluation and persuasion. Since such instruction is not offered either at the school or college levels in India, Indian graduate students in essence, never benefit from any formal instruction on developing such skills.

Some more specific pedagogical techniques to help solve Indian-specific writing problems might include:

1. To learn the usefulness of peer evaluation, Indian graduate students should be allowed to engage in group and collaborative activities in classroom situations. Such activities will not only help these novice writers to develop critical and
argumentative skills but will also give them a sense of belonging to an academic community.

2. It also seems that given the beginner Indian science writer’s propensity to write over-long sentences (giving rise to grammar-related problems such as tense and cohesion), instruction in syntax and grammar could be useful in some cases. Assignments should be provided to help develop editing skills for removing repetition and wordiness. A basic familiarity with the American punctuation system and publishing styles should also be encouraged.

3. Despite the common misperception that exists among many beginner Indian science writers that learning to give a “mathematical slant” to their writing is an index of their professionalization, writing instruction demonstrating that something said in mathematical language can just as well be put in prose should be beneficial. Such pedagogical exercises should emphasize that, while in some instances taking recourse to mathematical language might be the only viable and necessary alternative, at other times some things are best said in prose.

4. Ineffective writing due to inappropriate reduction or simplification of material (message adjustment strategies) can be corrected by providing instruction on writing “process” descriptions and explanations.

   Ideally, such instruction should be offered in American universities within the first year of students’ graduate programs with a view towards accelerating their socialization into western discourse communities. The fact that some dissertation writers from Old and New Immigrants (Group II) are still confused about the genre-based requirements of
scientific writing just as some of their counterparts in India are suggests that perhaps we need to redefine the focus of writing courses at the graduate level in the USA. Some thoughts should also be given towards making such courses in writing instruction mandatory in science and engineering departments in American universities.

The lower level writing courses that are currently open to international students often contain a mix of undergraduate and graduate students from different disciplines. It is entirely possible that Indian graduate students, due to their familiarity with the English language, will either not be required to take such lower level courses or will perform so well in them that the real source of their problems stemming from writing according to genre-specific discourse needs will remain unattended. The curricula of such existing writing courses should either be revised or be entirely replaced by an advanced level writing course contoured towards meeting the specific needs of international graduate students from the science and engineering departments. While the literature review on ESL instruction suggests that critics are divided on the issue of how best to offer such instruction (Spack 1988; Olsen and Huckin 1990; Parkhurst 1990), the possibility of team-teaching in which faculty from English, science and engineering departments collaborate should be explored.

It is hoped that this research will prove fertile material for future research – in devising appropriate writing instruction in order for Indian science writers to become better communicators and more productive members of their discourse communities in academia and industry.
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Indigenous Writers (Group I)

GENERAL DETAILS

1. What is your name and what department do you belong to?¹
2. Which part of India do you come from and what is your native language?¹
3. Where did you gain your higher education in India?
4. What was the medium of instruction, or, what language were you taught in? School/college?¹
5. Please describe your current research activities.
6. Are you a graduate student, post-doctoral or a faculty member?
7. If you are a post-doctoral or a faculty member, where did you write your dissertation? What was it on?

WRITING ACTIVITIES

1. What are some of the kinds of writing that you do? Number of publications?
2. Describe how you write.
3. Do you use an outline? Rough draft? Or do you write as you go along?
4. Do you write directly on the computer? Insert additional points later on?
5. Do you revise, edit, and proofread?
6. Do you invite peer evaluation? At what point? Do your review comments pertain mostly to rhetorical/stylistic/grammatical changes?
7. What are the differences in writing approaches between the scientific article and the dissertation?

¹ Adapted from Shaw (1991).
8. When you think about your research activities and try to organize your writing, which language do you think in? 

9. When you write, do you use a bilingual dictionary? 

10. Do you write entirely in English, or, do you fall back on your native language for difficult problems? 

ORGANIZATION & RHETORICAL STRUCTURE

1. Do you frequently use the IMRAD (Introduction, Methods, Results, and Discussion) format? 

2. Comments:
Which do you write first?
Which do you find easiest to write? 
Which do you find most difficult to write? 
Why? 

3. Abstract - do you write it right at the start? Or at the end? 

4. What about the Introduction? 

5. Comments on word limit. 

6. Do you think of the entire outline before writing or do you develop writing as you write? 

7. In the review of literature and discussion segments, citation of previous research is important. What purpose does it serve in your writing? Do you use it as part of your persuasive strategy?
8. How did you learn to write according to the IMRAD format? How did you become familiar with this format?

9. How did you learn to organize the individual sections in your dissertation/thesis/paper?

10. Did you receive any instruction in scientific writing in India? Or was it self-taught in your case?

WRITING INFLUENCES: SOURCES & FEEDBACK

1. Is scientific information easily accessible in India? While in India, how do you keep yourself abreast of recent research activities in your field?

2. When you are reading an interesting piece of research, what is the method of storing and retrieving that information for your own use?1

3. If you come across certain useful phrases while you are reading, do you make a note of them? What determines this strategy and how is it useful?1

4. Does the language or style of your source influence you in any way? How?1

5. Do you study sources as models? Imitation of models?

6. When you write, do you use your own language or do you find it easier to use the language of published material occasionally?1

7. Are you familiar with peer evaluation in India? Is it traditionally supportive or competitive?

8. Do you discuss your research writing with your colleagues in India? What language do you use? Do you benefit in any way from such discussions?1

9. Did you show successive rough drafts to your advisor? What sorts of comments
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did you get?

10. Do you review drafts written by others? Does that benefit you in some way?

How did this affect your writing?

11. Comments on collaborative writing?

LANGUAGE CONCERNS

1. Can you identify some of the writing problems that you are faced with?

2. Do you have problems with Tense? Sentence construction? Style? Vocabulary?

Transitions? Please expand or give details.

3. What according to you are the differences between a skilled and an unskilled writer? What acquired writing skills transform an unskilled writer to a skilled writer?

CULTURAL, RHETORICAL AND WRITING CONTRASTS

1. How does the academic system impact on the writing proficiencies of Indian science writers? Is instruction in scientific writing encouraged in schools and colleges?

2. Is critical thinking encouraged in India? Or is unquestioning acceptance of text and teachers the norm?

3. How has this ability, or the lack of it, affected your writing - especially in the development of a clear argument? Any suggestions?

4. Publication culture in India:

    a) What inducements does the academic environment provide?

    b) Is writing the dissertation the first attempt at academic writing?
c) What about paper publication in academic journals?

5. a) Have you published in international journals? How many?

b) How many drafts did you write? What sort of review comments did you get?

c) Were they organizational/ rhetorical/technical in nature? Other difficulties?

d) Were they accepted/rejected after the revisions were incorporated?

e) Samples?

6. What sort of writing preparations/research did you make before submitting articles?

7. What differences in writing requirements do you see while getting published in Indian scientific journals?

Language, Structure, Technical Matter, Style?

8. What other specific writing problems/differences can you comment on?

9. Can you identify, in a very broad way, the typical writing problems in the writings of your Indian students? Are they rhetorical, organizational or stylistic?²

10. Do you have any suggestions that might benefit Indian students in their attempts to get published in international journals?

² Applicable to faculty members only.
Old and New Immigrants (Group II)

GENERAL DETAILS

1. What is your name and what Department do you belong to?¹
2. Which part of India do you come from and what is your native language?¹
3. Where did you gain your higher education in India?
4. What was the medium of instruction, or, what language were you taught in?
   School/ college?¹
5. Please provide a description of your current research activities.
6. Are you a graduate student, post -doctoral or a faculty member?
7. What degree did you hold when you came to USA?¹
8. How long have you been in the USA?
9. If you are a post -doctoral or a faculty member, where did you write your dissertation?

WRITING ACTIVITIES

1. What are some of the kinds of writing that you do? Number of publications?
2. Describe how you write
3. Do you use an outline? Rough draft? Or do you write as you go along?
4. Do you write directly on the computer? Insert additional points later on?
5. Do you revise, edit, and proofread?
6. Do you invite peer evaluation? Do your review comments pertain mostly to rhetorical/ stylistic/ grammatical changes?
7. What are the differences in writing approaches between the scientific article and the dissertation?

8. When you think about your research activities and try to organize your writing, which language do you think in?\(^1\)

9. When you write, do you use a bilingual dictionary?\(^1\)

10. Do you write entirely in English, or, do you fall back on your native language for difficult problems?\(^1\)

ORGANIZATION & RHETORICAL STRUCTURE

1. Do you frequently use the IMRAD (Introduction, Methods, Results, and Discussion) format?

2. Comments:

   Which do you write first?

   Which do you find easiest to write?\(^1\)

   Which do you find most difficult to write?\(^1\)

   Why?

3. Abstract - do you write it right at the start? Or at the end?

4. What about the Introduction?

5. Comments on word limit.

6. Do you think of the entire outline before writing or do you develop writing as you write?
7. In the review of literature and discussion segments, citation of previous research is important. What purpose does it serve in your writing? Do you use it as part of your persuasive strategy?

8. How did you learn to write according to the IMRAD format? Were you familiar with this format in India?

9. How did you learn to organize the individual sections in your dissertation/thesis/paper?

10. Did you receive any instruction in scientific writing in India? Or was it self-taught in your case?

WRITING INFLUENCES: SOURCES & FEEDBACK

1. Is scientific information more easily accessible in USA? While in India, how did you keep yourself abreast of recent research activities in your field?

2. When you are reading an interesting piece of research, what is the method of storing and retrieving that information for your own use?¹

3. If you come across certain useful phrases while you are reading, do you make a note of them? What determines this strategy and how is it useful?¹

4. Does the language of your source influence you in any way? How?¹

5. Do you study sources as models? Imitation of models?

6. Did your perception of sources as models change in any significant way once you arrived in the USA?
7. When you write, do you use your own language or do you find it easier to use the language of published material occasionally? 

8. Were you familiar with peer evaluation in India? Was it traditionally supportive or competitive?

9. How useful do you find it in the USA?

10. Did you discuss your research writing with your colleagues in India? What language did you use?

How has this changed now that you are in the USA? Do you benefit in any way from such discussions?

11. Did you show successive rough drafts to your advisor in India? What sorts of comments did you get? How has this changed in the USA?

12. Do you review drafts written by others? Does that benefit you in some way?

How did this affect your writing?

13. Comments on collaborative writing?

LANGUAGE CONCERNS

1. Can you identify some of the writing problems that you are faced with?


3. What according to you are the differences between a skilled and an unskilled writer? What acquired writing skills transform an unskilled writer to a skilled writer?
1. How is the academic environment different between India and the USA? Was instruction in scientific writing encouraged in schools and colleges in India?1

2. Is critical thinking encouraged in India? Or is unquestioning acceptance of text and teachers the norm?

3. How has this ability, or the lack of it, affected your writing in the USA - especially in the development of a clear argument?

4. Publication culture in India:
   - What inducements did the academic environment provide?
   - Is writing the dissertation the first attempt at academic writing?
   - What about paper publication in academic journals?

5. Has your perception of academic writing changed in any way since you started writing in the USA? What differences do you perceive between writing in India and in the United States? What difficulties did you face? What advantages did you have?

6. What other specific writing problems/differences can you comment on?

7. Can you identify, in a very broad way, the typical writing problems in the writings of your Indian students? Are they rhetorical, organizational or stylistic?3

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3 Applicable for faculty members only.
Foreign-Returned (Group III)

GENERAL DETAILS

1. What is your name and what department do you belong to?¹

2. Which part of India do you come from and what is your native language?

3. Where did you gain your higher education in India?¹

4. What was the medium of instruction, or, what language were you taught in?
   School/College?¹

5. Please describe your current research activities.

6. Are you a post-doctoral or a faculty member?

7. What degree did you hold before you went to the USA?¹

8. How long have you been in the USA, or, for how long did you stay there?

9. If you are a post-doctoral or a faculty member, where did you write your dissertation? What was it on?

WRITING ACTIVITIES

1. What are some of the kinds of writing that you do? Number of publications?

2. Describe how you write.

3. Do you use an outline? Rough draft? Or do you write as you go along?

4. Do you write directly on the computer? Insert additional points later on?

5. Do you revise, edit, and proofread?

6. Do you invite peer evaluation? At what point? Do your review comments pertain mostly to rhetorical/ stylistic/grammatical changes?
7. What are the differences in writing approaches between the scientific article and the dissertation?

8. When you think about your research activities and try to organize your writing, which language do you think in?¹

9. When you write, do you use a bilingual dictionary?¹

10. Do you write entirely in English, or do you fall back on your native language for difficult problems?¹

ORGANIZATION & RHETORICAL STRUCTURE

1. Do you frequently use the IMRAD (Introduction, Methods, Results, and Discussion) format?

2. Comments:
   Which do you write first?
   Which do you find easiest to write?¹
   Which do you find most difficult to write?¹
   Why?

3. Abstract - do you write it right at the start? Or at the end?

4. What about the Introduction?

5. Comments on word limit.

6. Do you think of the entire outline before writing or do you develop writing as you write?
7. In the review of literature and discussion segments, citation of previous research is important. What purpose does it serve in your writing? Do you use it as part of your persuasive strategy?

8. How did you learn to write according to the IMRAD format? Were you familiar with this format in India?

9. How did you learn to organize the individual sections in your dissertation/thesis/paper?

10. Did you receive any instruction in scientific writing in India? Or was it self-taught in your case?

WRITING INFLUENCES: SOURCES & FEEDBACK

1. Is scientific information more easily accessible in USA? While in India how did you keep yourself abreast of recent research activities in your field?

2. When you are reading an interesting piece of research what is the method of storing and retrieving that information for your own use?

3. If you come across certain useful phrases while you are reading, do you make a note of them? What determines this strategy and how is it useful?

4. Does the language or style of your source influence you in any way? How?

5. Do you study sources as models? Imitation of models?

6. Did your perception of sources as models change in any significant way once you arrived in the USA?

7. When you write do you use your own language or do you find it easier to use the language of published material occasionally?
8. Were you familiar with peer evaluation in India? Was it traditionally supportive 
or competitive?

9. How useful do you find it in the USA? Do you continue it in India?

10. Did / Do you discuss your research writing with your colleagues in India? What 
language did you use?

How was this different in the USA? Did you benefit in any way from such 
discussions?

11. Did you show successive rough drafts to your advisor in India? What sorts of 
comments did you get? How was this changed in the USA? Comments on the 
differences in feedback between the two countries?

12. Do you review drafts written by others? Does that benefit you in some way?

How did this affect your writing?

13. Comments on collaborative writing?

LANGUAGE CONCERNS

1. Can you identify some of the writing problems that you are faced with?

2. Do you have problems with Tense? Sentence construction? Style? Vocabulary?

Transitions? Please expand or give details.

3. What according to you are the differences between a skilled and an unskilled 
writer? What acquired writing skills transform an unskilled writer to a skilled 
writer?
CULTURAL, RHETORICAL AND WRITING CONTRASTS

1. How is the academic environment different between India and the USA? Is instruction in scientific writing encouraged in schools and colleges?  

2. Is critical thinking encouraged in India? Or is unquestioning acceptance of text and teachers the norm? 

3. How had this ability, or the lack of it, affected your writing in the USA- especially in the development of a clear argument? 

4. Publication culture in India:
   a) What inducements does the academic environment provide? 
   b) Is writing the dissertation the first attempt at academic writing? 
   c) What about paper publication in academic journals? 

5. How did your perception of academic writing change once you started writing in the USA? What difference do you perceive between writing in India and in the United States? What difficulties did you face? What advantages did you have? 

6. What differences in writing requirements do you see between Indian and international scientific journals: language, structure, technical matter, style? 

7. What other specific writing problems/differences can you comment on? 

8. Can you identify, in a very broad way, the typical writing problems in the writings of your Indian students? Are they rhetorical, organizational or stylistic? 

9. Do you have any suggestions that might benefit Indian students in their attempts to get published in international journals?
Native-Speaking Faculty (Group IV)

1. What predominantly are your impressions about Indian students as dissertation writers?

2. Do you notice any particular trait/characteristic in their writing?

3. Do they tend to have any typical writing problem(s) when they first arrive?
   (a) organization (b) word-choice/ vocabulary (c) grammar and mechanics

4. In which sections in a typical IMRAD format do they encounter most of their writing obstacles?
   (a) Introduction (b) Methodology (c) Results (d) Discussion (e) Problem-Solving/Analytical (f) Review of Literature

5. What specific writing differences do you see between native speakers and Indian graduate students?

6. What is the most important writing skill that they need to focus on?4
   (I) Defining objective/ problem
   (II) Establishing valid generalizations
   (III) Substantiating claims and assertions
   (IV) Inferring valid conclusions
   (V) Writing in own language
   (VI) Making coherent and logical connections

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4 Adapted from Jenkins et al. (1993).
APPENDIX B

A BRIEF OUTLINE OF THE HISTORY OF ENGLISH EDUCATION IN INDIA
The introduction of English education in India began as the East India Company acquired a stronger foothold in the Indian subcontinent in the eighteenth century. In 1759, missionaries were permitted entry into India, and in 1787, the Court of Directors granted approval to Reverand Swartz to convince the Rajas of Tanjore and Marwar to found schools for providing instruction in English (Wadia 1954). The recommendations of the Macaulay Minutes (1835) proposed to “do our best to form a class who may be interpreters between us and the millions whom we govern; a class of persons Indian in blood and color, but English in taste, in opinions, in morals, and in intellect ....” To this end, “all the funds appropriated for the purpose of education” were thought to “be best employed on English education alone” (Aggarwal 1983: 11-14).

John Miller wrote the first book to teach English called *The Tutor: Or New English and Bengalee Work. Well adapted to Teach the Natives English* which was published in Serampore in Bengal in 1797. Although three options were open (classical oriental languages such as Sanskrit and Arabic, vernacular Indian languages such as Tamil, Bengali, Hindi, etc., and English) as the language of instruction, the fact that English superseded the other languages as the dominant language is seen as an expression of British cultural imperialism (Agnihotri and Khanna 1995). Wood’s despatch in 1854 ensured the official dominance of English language in India: “We look, therefore, to the English language and to the vernacular languages of India together as the media for the diffusion of European knowledge ....” (Aggarwal 1983:16).

The association of English with notions of “power,” privilege and “prestige” is rampant yet today: while English has become the language for the educated “elite,” the
neglected vernacular Indian languages have been used by the masses in “peripheral
domains” (Agnihotri and Khanna 1995).

English education in India was marked by a concern for “language correctness”
and was facilitated through the study of a selection of classical texts in British Literature.
Typical anthologies compiled to introduce colonial India to the “best literature and
culture” invariably included plays by Shakespeare, a selection of poetry by Milton,
Dryden, Pope, Wordsworth and Keats, or novels by Fielding and Meredith among others.
Instruction focused on reading, comprehension, and a critical appreciation of selected
literary texts. Exercises in translation, grammar, “vocabulary building and memorization
of paradigms” formed the basis of pedagogical strategies for language learning in English
(Agnihotri and Khanna 1995:20). Since the classical Indian languages such as Sanskrit
and Persian were learned on the “kavya(literature) – vyakaran (grammar)” mode, the
same tradition was continued for learning English. Texts were interpreted with the aid of
a dictionary and a grammar book for the “rules of inflection and syntax.” The syllabus in
missionary schools included the Bible, Paley’s Natural Theology, Bunyan’s Pilgrim’s
Progress, Bacon’s Novum Organum or Plato’s Dialogues (Krishnaswamy and Sriraman
1995). The nature of English education in India was decidedly classical, even at a time
when it was on the wane amongst the emerging middle-class in England.

English education in postcolonial India (1947) continued on a similar vein, with
increased emphasis on the teaching and learning of Indian vernacular languages. The
“Direct Method” replaced the old literature – grammar mode of education. The social
stratification that resulted in the creation of two classes in relation to sustaining English in
the Indian society was reflected in the two “distinct” school traditions: the English-medium convent and public schools where spoken and written English received primary focus for the elite, and the local government schools where the medium of instruction upto the primary level is the regional language. In the latter case, instruction in English began only from Class V and eventually became the medium of instruction for other subjects such as science and mathematics in higher classes. English was taught in the native vernacular language initially, and students were subsequently moved up to reading poems, short stories and plays by British writers (Agnihotri and Khanna 1995). In modern India, successive Commissions on educational policies (Radhakrishnan Commission 1949; Kothari Commission 1966; Ramamurti Commission 1990) have recommended the use of vernacular Indian languages in educational institutions, leaving English with the status of a “link” or “library” language in India (Krishnaswamy and Sriraman 1995).
APPENDIX C

SOME SALIENT FACTS ABOUT RESPONDENTS IN THE STUDY
### Table C.1 Some Salient Facts About Respondents in the Study

<table>
<thead>
<tr>
<th>Group Description</th>
<th>Scientific Writing Instruction in India</th>
<th>Writing</th>
<th>Language of High School Instruction</th>
<th>Average number of Publications</th>
<th>Average Length of Stay in USA/UK (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td>(years)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Computer</td>
<td>Longhand</td>
<td>Native Language</td>
<td>English</td>
</tr>
<tr>
<td>I Indigenous Writers N=8</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>II Old and New Immigrants N=13</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>III Foreign-returned N=7</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>7</td>
<td>0</td>
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</tbody>
</table>

N = Total number of respondents in the group
x = Not applicable in these groups.
APPENDIX D

ADDITIONAL SAMPLES OF DRAFT REVISIONS
Some samples of original (o) and revised (r) versions showing changes made in grammar, language, and vocabulary:

**GROUP I**

**Singular/Plural**

1. “Amongst the metabolic specializations which are ought to be present....” (o)

   “Amongst the metabolic ... are present ....” (r)

**Vocabulary/Word-choice**

1. “Device” replaced with “mechanism”

2. “There are reports of a good correlation between invertase increment and higher plant growth but the function of higher plant invertases is poorly understood so far.” (o)

   “Reports are available on correlation between invertase increment and higher plant growth. However, the function of invertases produced by higher plant is poorly understood.” (r)

3. “Was identified” replaced with “which exhibited”

   “Maximal” replaced with “maximum”

4. “Recently Grossman and Zimmerman (1974) found that ....” (o)

   “However, Grossman and ....” (r)

5. “The present paper is aimed at segmenting images obtained by Confocal Laser beam Scanning Microscope (CLSM), which can give an array of images ....” (o)

   “ The present paper ... which can produce an array ....” (r)

6. “Each image in the stack” replaced with “image stack”
Reference problems (a, an, the, these, the)

1. "Freshly fallen leaf litter of three different types of trees namely Paksunga, Trewia, Kadam and Bamboo were collected and dried for three days in a 60 degree oven. The weight of the leaves were then determined ...." (o)
   
   "Freshly fallen leaves of Paksunga ...oven. Then, these were weighed ...." (r)

2. "Fructose formation from sucrose is a enzymatic step reaction." (o)
   
   "The production of fructose from sucrose is a single step reaction." (r)

3. "However, significant increase ...." (o)
   
   "However, a significant increase ...." (r)

4. "Each of these images can be considered as a 2D image slice of a 3D specimen." (o)
   
   "Each of these ... 2D image slice of the 3D specimen." (r)

Sentence Constructions

1. "In these experiments neither the number of snail nor the time taken was a factor since the amount of litter was fixed and at no time it was found that the gastropods could degrade the total amount of food offered to it if the number of snails were increased less time taken to degrade the same percentage of the particular leaf detritus." (o)
   
   "In these ... at no time it was possible for these gastropods to degrade ... offered. When the number of snails was increased the time taken to ... percentage of a particular type of leaf detritus was less." (r)

2. "Because of the second order derivatives, the operator is more sensitive to noise." (o)
   
   "The operator consists of second order derivatives, and hence is more sensitive to noise." (r)
GROUP II

Vocabulary/Word-choice

1. "Also" replaced with "furthermore"

2. "Temperature" replaced with "heat"

3. "Done" replaced with "performed"

Reference Problems (a, an the, etc.)

1. "A risk is based on ...." (o)
   "Risk is based on ...." (r)

Sentence Construction

1. "In a distributed system, a set of processes, may be executing on the same physical computer or on different computers, cooperate to achieve a common goal." (o)
   "In a distributed system, a set of processes, executing on the same or on different computers, cooperate to achieve a common goal." (r)

2. "Most other proteins contain tryptophan which has got a much ...." (o)
   "Most other ... has a much ...." (r)

GROUP III

Transformation

1. "No doubt, the deformation of the early lineation was achieved by the simultaneous effects of ...."(o)
   " It is therefore justified to start with the working hypothesis that the deformation of the early lineation ...." (r)

2. " In both instances, the lower the percentage of partial melting, the higher is the degree of partitioning in ... the melt." (o)
"In both instances, ... the higher is the concentration of the elements in ... the melt." (r)

**Vocabulary and Word-choice**

1. "Aspects" replaced with "respects"

2. "... does not necessarily rule out genetic nexus with some ...." (o)
   
   "... does not necessarily rule out genetic connection with ...." (r)
APPENDIX E

LIST OF RESEARCH AREAS OF RESPONDENTS IN THIS STUDY
Studies in Extracellular Enzyme Invertase (Microbiology)
Repetitive DNA Sequences in T. Ferraoxidans (Microbiology)
Studies in the Ecosystem of Ponds (Zoology)
Neural Networks and Artificial Intelligence (Computer Science)
Image Processing (Computer Science)
Metamorphic Petrology (Geology)
Multi-Phase Flow in Different Systems (Chemical Engineering)
Power System Planning (Mechanical Engineering)
Protein Structure (Biochemistry)
Manufacturing and Simulation System (Industrial Engineering)
Effect of Lasers on Atoms (Physics)
Distributed Systems (Computer Science)
Protein Interaction in the MCRBC System (Microbiology)
Efficient Representation and Manipulation of Large Databases (Chemical Engineering/ISDS)
Environmental and Water Resources Engineering (Civil Engineering)
Transformation of Chemicals in the Environment (Chemical Engineering)
Solid State Electronics (Electrical Engineering)
Fluid Mechanics (Mechanical Engineering)
Decontamination of Soils (Civil Engineering)
Behavior of Composite Materials (Civil Engineering)
Genesis of Ore Geology (Geology)
Pattern Recognition, Fuzzy Sets and Systems (Computer Science/Engineering)
Economic Geology (Geology)
Protein Structure (Biophysics)
Applied Chemistry
VITA

The author was born on May 31, 1961, in Calcutta, India. She graduated with a Bachelor’s degree in English from the Presidency College, Calcutta, in 1983. She earned her Master’s degree in English from the University of Calcutta in 1986. After graduation, she worked as a journalist for two years and wrote for two English language dailies in Calcutta: first, for the Amrita Bazar Patrika and then, for The Statesman until 1990.

The author moved to Baton Rouge, Louisiana, following her marriage in 1990. Upon joining the Louisiana State University, she gained a Master’s in English in 1996. As a graduate student at the university, she worked as a research assistant in the College of Engineering as a technical writer, and subsequently, as a graduate teaching assistant in the Department of English. Since the summer of 1997, she has been working as a part-time instructor teaching writing courses in the Department of English. She will receive her degree of Doctor of Philosophy in May of 1998.
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Sumita Roy

Major Field: English

Title of Dissertation: The Socialization of Indian Scientific Writers into Western Scientific Discourse Communities

Approved:

[Signatures]

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination: 10/17/97