Communication Strategies in the Writing of Scientific Research Articles by Non-native Users of English

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Abstract — This paper compares the communication strategies used by representatives of two generations of French scientists (pre- and post-Communicative Language Teaching) in the writing of research articles to be published in specialised anglophone journals. Beyond traditional errors in lexis and syntax, the focus is on those communication strategies that may be attributable to two fundamentally different attitudes towards foreign language learning: using the language precisely as a tool to meet the requirements of a specific task only (a sort of "use-and-forget" attitude), or taking advantage of all possible situations to try to expand one's resources with a view to improving one's overall performance in the use of the language. The paper looks particularly at some aspects of the treatment by the two groups of the relationships between general argumentative language and hard-core mathematical language in the form of equations and formulae.

Introduction

Before dealing with a growing aspect of English for Specific Purposes, namely helping science and technology colleagues with the writing of their research papers in English, it may be useful to define the notion of "communication strategies" as used in this paper. Our definition is borrowed from Tarone (1983: 64), for whom "communication strategies are used to compensate for some lack in the linguistic system, and focus on exploring alternate ways of using what one does know for the transmission of a message, without necessarily considering situational appropriateness" (my italics).

In the case of specialised articles written in English, "situational appropriateness" translates as "contextual relevance" or "register awareness". Swales refers to "rhetorical awareness" as "being able to guess how referees will react to a particular text", and also notes that "phenomena only acquire fact-like status by consensus and that consensus may not be achievable without rhetorical persuasion" (Swales 1990: 112). Unfortunately, these aspects are often given short shrift by our occasional article writers. This lack of situational awareness is often the main reason for the rejection of their articles by reviewers when the texts submitted are globally correct in terms of lexis and syntax.
“Situational appropriateness” here means adherence to the written genre of specialist scientific articles in general but also to the particular style of a given journal, not to mention the specific requirements of a profession or of a scientific domain. Language inadequacy may also be an easy excuse for rejecting unwanted papers, especially when a breakthrough heralds new patents and industrial applications or threatens old ones, a situation not often encountered in the human sciences. A certain amount of subjectivity also exists on the part of reviewers even when assessing the English of native-speaking science contributors. As Crosnier (1994: 54) notes: “We can also encounter conflicting situations in which anglophones having two addresses or two research laboratories are involved: their English is praised or criticised depending on whether they are in England or France” (my translation).

The present study was prompted by the rejection of two articles written by researchers working in the laboratories of a French “Grande Ecole” and wishing to publish the results of their work in anglophone specialised journals. The first article was in the field of structural dynamics and mechanical engineering. Its authors, both in their early fifties, were full professors and enjoyed well-established reputations in their fields of specialization, at least in France. However, most of their publications were in French (and some in German for one of them) with a few occasional writings in English made possible only with considerable assistance from professional translators and/or linguist colleagues. Both researchers admitted to having only “referential” knowledge of English, meaning that they were better prepared to extract information from reference materials written in English than to interact and communicate effectively in writing or orally with English-speaking people. Both researchers also did not feel particularly motivated towards learning English beyond acquiring “a few recipes and tips” on how to improve their written skills with, no doubt, the secret hope of eventually becoming autonomous in the writing of their publications in English.

The other rejected article was in the field of geotechnics and had been written by three younger researchers, all assistant professors aged 30, 32 and 33, who had, at the time, already published a total of 10 articles in French, three of them in joint authorship. The present rejected article was their first co-authored article in English. The three younger researchers had all been through what is now conventionally called a Communicative Language Teaching (CLT) approach in English, i.e. the now well known type of teaching aimed at developing interactive skills, favouring content over form both orally and in writing (“semantic syllabus”, “getting the message across”, “fluency rather than accuracy”, etc.) and also at making room for the discursive component in the use of a foreign language. All three were highly motivated towards improving all possible aspects of their English. Indeed, one of them even contemplated joining an English-language research team at a Canadian university. Contrary to the older group, the need to be able to publish in English was fully accepted by the three younger scientists from the very beginning of their careers as researchers.

Both articles had been refused not so much because of serious lexical or syntactic errors (these were not so many and could have been taken care of by
a local editorial team), but rather because of such comments as “discontinuity in the argumentative process” (article in geotechnics), “lack of consistency” (article in structural dynamics) and “failure to convincingly introduce, link or conclude various key-elements in several parts of the demonstration” (article in structural dynamics). One possible explanation for the common negative result could be that both groups had in fact reached a point in their practice of the language where what mattered first was content, not form. Each group had reached the same point via different routes, though: the first group of researchers (hereafter Group I) had never really felt interested in devoting time and attention to form in English. They had a strong belief in the preponderence of the thematic content of what they wished to communicate, a sort of “facts-and-figures-speak-for-themselves” attitude, over the rhematic aspect of their written communication. This lack of interest in form concerned mainly the improvement of syntax wrongly considered to have been acquired once and for all during the “institutional” period of learning. This corroborates Richards and Sampson who mention Ervin-Tripp’s observation (1970) that “the adult’s strategies of language learning may be more vocabulary oriented than syntactic. Acquisition of syntax poses a task for the adult which is not easy” (Richards and Sampson 1974: 10).

The second, younger group of researchers (hereafter Group II) demonstrated the limitations of a CLT approach implemented without due consideration given to register analysis and textual consistency. It seemed the “communication first, form later” orientation was more easily applicable to oral expression than to the written one, especially when the latter concerned a genre not systematically taught, at least not in the initial teaching stage, in most English for Science and Technology (EST) courses.

Strategical Errors

In their introduction, Group I adopted the well-tried approach in three steps which consists of (1) identifying the need for an efficient method to solve a well-known problem; (2) setting one’s present work in perspective by recalling previous research by other specialists in the field; (3) demonstrating the relative inadequacy of former methods and justifying the present one. However, in the present instance, step (3) consisted of a rather non-committed description of previous methods in which advantages counterbalanced disadvantages with the resulting consequence of presenting these methods somewhat neutrally, as in this sample (uncorrected) paragraph:

The “locked boundary modes” method: This method initiated by H....and G.... uses sub-structural modes with locked boundary conditions, i.e. the modes of each of them are calculated with clamped boundary conditions. This method has been widely developed and extended to mechanical systems. The latest innovation by L.... has made it possible to display the neglected residual term in the frequency analysis...

Unfortunately, the purpose of the authors was precisely to demonstrate the limitations of the locked boundary modes method and to advocate their own
“free modes” method. When questioned about the reasons for their ambiguous approach, both researchers said that they felt “their command of the language did not allow them to express negative impressions, let alone disparagement, worded with the necessary shades of meaning not to appear rude and run the risk of antagonising their foreign fellow-researchers” (my approximate translation).

Unsurprisingly, this failure was noticed by at least one receiver who wrote the “lack of consistency” and “faulty introductions” comments already mentioned. The rejection of this article was only partly due to compensatory strategies like excessive use of mathematical language. In this particular case, the main reason for the rejection was certainly inadequate mastery of the language of argumentation. However, the ensuing remedial EST teaching did not bear on the many ways of implying inadequacy in others, but rather on how to look at unsatisfactory phenomena and suggest ways of improving them. The focus shifted from persons to objects which, not surprisingly, the authors felt better prepared to speak of in unfavourable terms. The Group I researchers’ difficulty in this area reveals how culture-bound attitudes and poorly mastered foreign language can conspire to affect the way a chain of reasoning can be perceived by others in an otherwise logical three-step type of introduction.

On the other hand, Group II, in several paragraphs of their article on geotechnics, may have exhibited too much self-confidence: They sometimes forgot a self-imposed rule of impersonality, lapsed into transcribed oral style and, in some instances, reversed the tendency observed in Regent (1985: 105-120) for French research article writers not to be target-oriented. The following sample (uncorrected) paragraph is a good example:

> Consequently within each load increment {API, the gradient matrices \([Y_{rG}]\) and \([Y_{rF}]\) are computed at the end of the previous step. These matrices entirely define the tangential stiffness matrix. Using previous incremental relations, the increase of the displacements, strains (total, elastic and plastic) and stresses, can then be calculated. This we have finally achieved by a simple algorithmic solution: a Euler scheme in which the exact curve is approximated by a series of straight lines, with a slope equal to the start of the increment. Another variant we have thought of uses constant stiffness for each load increment but provides a correction procedure for the out-of-balance modal forces at the next increment or iteration.”

The authors have, in this particular instance, run some risks: they have undertaken to structure their reasoning by using cohesive devices (“consequently”; “this” used as a pronoun at the beginning of a sentence) which contribute to recreating in writing the dynamic unfolding of the scientific experimental process.

Not all of the flaws pointed out by the reviewers seemed to be due exclusively to a poorly mastered foreign language, but rather to a lack of familiarity with the discourse conventions of science writing in English. However, both groups came to me, their EST colleague, for immediate remedial action on the rejected articles and also for more lasting advice to be applied to further productions. I found myself, then, in the position of a forensic doctor having to practice a post-mortem and comment on it to the murderers at his side.
The differences in age, motivation and general attitude between the two groups seemed to be a perfect illustration of what Gardner and Lambert (1959) call "instrumental motivation" and "integrative motivation". The first category of "instrumentally motivated" learners are described as only caring about acquiring the tools for dealing immediately or punctually with a particular foreign language situation or function, e.g. "being able to find one's way in a new town" or "questioning a lecturer at the end of an oral presentation", because these things are inescapable for a researcher nowadays. What we knew of the background and general attitude toward foreign languages of Group I seemed enough to qualify them as "instrumentally motivated" users of the language. The younger researchers, Group II, seemed, at first sight, to conform to the second definition of "integratively motivated" learners, who are described as eager to assimilate a foreign language fully with the ultimate goal of eventually becoming part of a different linguistic and cultural community (Gardner & Lambert, 1959).

The two definitions given by Gardner and Lambert can be said to be static inasmuch as no particular action or strategy toward acquiring the language is mentioned as being linked to one or the other motivation. The active side of the two different attitudes can perhaps be found in Corder's analysis of two strategies of communication options open to the learner:

The learner will sometimes wish to convey messages which his linguistic resources do not permit him to express successfully. When in the course of interaction the learner finds himself faced with this situation, he has only two options open to him. He can either tailor his message to the resources he has available, that is, adjust his ends to his means. These procedures we can call message adjustment strategies, or risk avoidance strategies. Or he can attempt to increase his resources by one means or another in order to realize his communicative intentions. These strategies we can call resource expansion strategies. These are clearly "success-oriented" though risk risk-running strategies. (Corder 1983: 17)

Micro-strategies to Avoid Difficulties

Having tentatively linked Gardner and Lambert's definitions of two learning motivations and Corder's two types of communication strategies for the purpose of having two convenient models of learner behaviour for our demonstration, the basic questions the rest of the present study will explore are the following: (1) Do "instrumentally motivated" learners resort to message adjustment strategies and thus avoid risks? (2) do "integratively motivated" learners adopt resource expansion strategies, thereby running more risks of making errors? and (3) do differences in motivation result in different types of specialist text?

As a possible first step toward answering the questions, I checked whether the various communication strategies Corder assigns to one or the other category were adopted by the two groups of researchers in the writing of their article. Before analysing the language strategies used by the NNS specialist writers, it might be useful to define the methodology chosen for that purpose.
TABLE 1
Frequency of micro-strategies used by two groups of researchers

<table>
<thead>
<tr>
<th>MESSAGE ADJUSTMENT STRATEGIES</th>
<th>GROUP I Based on analysis of 270 sentences(^1)</th>
<th>GROUP II Based on analysis of 329 sentences(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic avoidance</td>
<td>6(^{\circ})</td>
<td>2(^{\circ})</td>
</tr>
<tr>
<td>Semantic avoidance</td>
<td>10(^{\circ})</td>
<td>6(^{\circ})</td>
</tr>
<tr>
<td>Message reduction</td>
<td>37(^{\circ})</td>
<td>21(^{\circ})</td>
</tr>
<tr>
<td>Message abandonment(^2)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>RESOURCE EXPANSION STRATEGIES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borrowing (a few isolated</td>
<td>3(^{\circ})</td>
<td>3(^{\circ})</td>
</tr>
<tr>
<td>words from French, with or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>without anglicising)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switching: (a) to a complete</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>sentence in French</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switching: (b) to mathematical</td>
<td>16(^{\circ})</td>
<td>10(^{\circ})</td>
</tr>
<tr>
<td>language half-way through</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sentence or paragraph</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraphrase or circumlocation</td>
<td>6(^{\circ})</td>
<td>10(^{\circ})</td>
</tr>
<tr>
<td>Paralinguistic devices:</td>
<td>20(^{\circ})</td>
<td>6(^{\circ})</td>
</tr>
<tr>
<td>(a) mathematical language</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paralinguistic devices:</td>
<td>4(^{\circ})</td>
<td>6(^{\circ})</td>
</tr>
<tr>
<td>(b) tables, graphs and other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>illustrations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)Percentages have been rounded.

\(^2\)For Corder, this strategy applied mostly to oral communication. It was obviously impossible for our writers to leave a printed sentence unfinished. However, another form of message abandonment can be detected in sentences starting in general English and then switching to mathematical language. These have been listed under “switching” (b).

The first thing to note is that the two groups did not write their articles in French and then translate them into English. Both groups had chosen to start from a loose outline consisting mostly of a series of calculations and the description of one or two physical models. In their own words, the “mathematical line of argument” was developed to the maximum of its expressing value. Put differently, the equations, tables, illustrations and all other non-verbal devices (if equations can be said to be non-verbal) were written or drawn in such a way
that they would be as explicit and, hopefully, as self-explanatory as possible. This initial attitude is in itself a communication strategy and will be dealt with later in this study.

Having no original version in French to start from and not working in a translation context, I tried to reconstruct the writers' line of reasoning and purpose through an experimental method first suggested by Váradi (1980). Váradi investigated the communication strategies of Hungarian adults trying to adjust their oral description of pictures in English to conform as much as possible to an "optimal message". This message was itself based on an "optimal meaning" conveyed to the observer in the common native language they shared with him.

Using this method, I asked two groups of French researchers to retrace orally and in writing all the stages and articulations of their argumentative process in detail, using French for that purpose. It was then possible to account for the choice of a particular strategy whenever it cropped up in the text by matching it with the writers' intended optimal meaning. Each of the 270 and 329 sentences was then analysed and linked, first to a category of macro-strategy ("message adjustment" or "resource expansion") and then to a micro-strategy, following Corder (1983). Table 1 gives the percentage for each micro-strategy chosen by each group.

Judging from the figures, Group I definitely qualifies as a risk-avoiding group. Table 2 gives one example of each of the three micro-strategies used by this group. The optimal meaning version was never written but was offered to me during the retroactive analysis. The article version corresponds to a passage considered inadequate in the written article. This inadequacy was due either to what was felt by the reviewer as a missing step in a demonstration (topic avoidance), or as an ambiguous construction because of semantic evidence (What is

<table>
<thead>
<tr>
<th>Optimal meaning</th>
<th>Article version</th>
<th>Optimal translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Cette méthode utilise les modes de chaque sous-structure calculées en considèrent les frontières de chacune comme encastrées.&quot;</td>
<td>Topic avoidance</td>
<td>This method uses each substructure mode calculated as if individual border were embedded.</td>
</tr>
<tr>
<td>&quot;Trois catégories de modes peuvent être envisagées; nous allons développer de façon plus précise la méthodes des modes libres en montrant les améliorations que nous apportons.&quot;</td>
<td>Semantic avoidance</td>
<td>Three classes of modes can be considered; we intend to develop more precisely the free mode method and demonstrate the improvements it can offer.</td>
</tr>
<tr>
<td>&quot;On peut se poser des questions sur la complétude de la famille de déformées utilisée car il y a surabondance des modes basses fréquences au détriment des modes de fréquences associées plus élevées.&quot;</td>
<td>Message reduction</td>
<td>The completeness of the class of derived modes is questionable because there is an excess of low frequency modes at the expense of the associated higher frequency modes.</td>
</tr>
</tbody>
</table>

TABLE 2
Examples of micro-strategy use: Group I
it that we intend to demonstrate? That three types of modes are currently used? That the "free modes" method seems more precise?) or, again, because of incomplete information due to excessive reduction of the message.

The difficulties met by the reviewers in following our Group I writers along so many short cuts and blind alleys now become understandable. Group I conforms rather closely to the typical risk-avoiding, message-adjusting and instrumentally motivated learner model with a marked tendency to reducing its message. Similar examples of topic and semantic avoidance and message reduction strategies have also been found in the writing of Group II, albeit in smaller proportions (see Table 1).

In line with its greater orientation toward integrative motivation and the use of accommodation and resource-expansion strategies, Group II is definitely more inclined towards, and better at, paraphrasing and using circumlocation than Group I. This characteristic belongs, in our view, to good language learners and holds very promising pedagogical implications. As Corder (1983: 17) notes again: "It is part of good language teaching to encourage resource expansion strategies and (these) may eventually lead to language learning."

Table 3 shows several examples of micro-strategies conventionally assigned to "message adjusters" and used by Group II in their article. Borrowing occurs in limited amounts and, in nearly all cases, is prompted by etymological resemblances between French and English or the existence of "semi-cognates", i.e. words thought to be directly transferable from one to the other language but differing slightly in spelling: périmetre/perimetre is a case in point. When asked about these errors, Group II attributed them to lack of attention, an attitude not shared by the reviewers who systematically reacted to errors of this type.

<table>
<thead>
<tr>
<th>Optimal meaning</th>
<th>Article version</th>
<th>Optimal version</th>
</tr>
</thead>
<tbody>
<tr>
<td>sable renforcé</td>
<td><strong>Borrowing</strong> (with anglicization)</td>
<td>reinforced sand</td>
</tr>
<tr>
<td>périmetre</td>
<td>reinforced sand</td>
<td>perimeter</td>
</tr>
<tr>
<td>contigué</td>
<td>contiguous</td>
<td></td>
</tr>
</tbody>
</table>

Dans la majorité des cas les temps de calcul que nécessite le traitement d'un ouvrage sont prohibitifs.

| Switching (here to an abbreviation) | In most cases CPU (Computer Programming Unit) time is prohibitive. |

| Paraphrase (plus expansion) | The aim of the present study is to suggest a more accurate formulation of the basic elements. |

| L'objet de ce travail est de proposer une formulation plus précise des éléments de base. |
| The aim of this study is to present a more accurate formulation of the basic elements, one that will be more precise and reduce computational effort. |
Switching was never found to be to a French word or phrase, rather to abbreviations as in “CPU”, or even to a non-verbal device like an illustration. This latter strategy of using non-verbal devices was more often chosen by Group II who had been trained in this direction during an intensive EST training course followed the previous year. However, message reduction, often through simplification, is the preferred strategy of both groups (see Table 1). The simplification process is more expeditiously done by avoiding and not mentioning. The reason for this attitude is probably to be found in the fact that, as Jain (1974: 203) observes, these learners, after 20 years or more of instruction: “have reached a stage when they are no longer “testing their hypotheses’ about the second language; they have arrived at a system whatever it is ... There are areas of undeterminacy in (the learner’s) syllabus which give rise to systematic-unsystematic errors”.

As our writers knew that (1) whole areas in their language systems were uncontrollable or missing, and (2) that no more time and attention could be devoted to filling the gaps, they just applied the old maxim “If unsure, abstain”.

Using Mathematical Language: A Macro-strategy

In considering ways to improve their article in the eyes of English mother tongue reviewers, Group I, the older group of researchers, wanted to know first if some action could be taken in an area where they felt relatively secure. They wanted to know if they could use proportionately more mathematical language (ML), as this was the safer area for them. They felt at a disadvantage when using general language (GL).

GL (general language) must be understood as the expression of thought processes via words, sentences and paragraphs resulting in a prose continuum which is readable, if not understandable, by any lay person (see passage on the “locked boundary method” above). ML (mathematical language) here means equations and formulae only made up of figures and symbols referring to a pre-defined code or set of physical or mathematical laws. Some elements of the code or laws given in symbolic form can be verbalised in GL phrases like A ≥ B which can be expressed as “A is greater than or equal to B”.

Group I’s article on structural dynamics, numbered 7128 words and had a 1:4.8 ratio of ML to GL signs. Group 2’s geotechnics article totalled 5954 words, and had an ML/GL sign ratio of 1:17.4. Comparing the ratios of ML to GL signs of the two groups would be pointless since two different fields of scientific specialisation may require varying proportions of mathematical representation. However, comparing the use of mathematical representation by francophone researchers writing in English and by their anglophone counterparts within the same specialisation may reflect on the appropriacy of GL use exhibited by our non-native users.

A survey of 21 articles written by native, or near-native users in the field of structural dynamics revealed an ML to GL ratio of 1:10.1, meaning that GL is used more than twice as much by native speakers as it was by Group I (1:4.8).
the field of geotechnics yielded a 1:15.3 ratio of ML to GL, i.e. very close to the 1:17.4 exhibited by our Group II of younger researchers. Although in the present case both articles were rejected by reviewers acting on behalf of two different journals, but not for quite the same reasons, one may already note that the researchers in Group II were at least conforming better than their older colleagues to a quantifiable expectation of the written genre in their specialisation.

The high representation of GL in articles written by their native, or near-native, peers convinced both groups of French researchers of the inevitability of this component in the particular genre of the scientific research article. Later queries from them concerned possible learnable strategies to minimize risks when producing written GL.

The fundamental difference of attitude between the two groups is shown in the more systematic use of ML by Group I who admitted to spontaneously favouring this mode of expression and to resorting to GL, at least in English, only when pure ML could not account for the whole of their demonstration.

A typical example of over-reliance on ML in the article on structural dynamics is the following passage considered obscure by a reviewer, and even more so by me, their EST colleague, although probably for different reasons:

The equations of motion for the whole structure using Lagrange equations can be written as follows for each substructure:

\[ [M] \frac{d^2}{dt^2} \{x(t)\} + [K'] \{x(t)\} - [P'] \{A(t)\} = \{f(t)\} \text{ for } j = 1, 2, ..., N \]

(*) Damping is supposed negligible and matrices \([K']\) and \([M]\) are not assumed to be symmetrical. The extension of the method to symmetrical or non-symmetrical couplings between velocities presents no difficulties.

(**) We can also assume that the exciting forces are harmonic and we work in a harmonic steady state so that \(\{x'(t)\}, \{f'(t)\}, \{A'(t)\}\) designate algebraic magnitudes.

When asked to express the optimal meaning of sentence (*) in French, the authors offered: "Afin de ne pas alourdir les expressions des équations matricielles qui sont développées dans la suite, l'amortissement est supposé négligeable..." ("In order not to weight down the expressions of the matric equations which are developed further on, damping is supposed to be negligible"). In the authors’ own words, the reduced GL message stemmed primarily from their inability to express a single lexical notion: "alourdir". The phrase "in order not to" (= "afin de") was well known to both researchers, being so frequent in mathematical argumentation that "ça appartient au langage mathématique" ("This belongs to mathematical language").

For sentence (**), the optimal meaning obtained was: "afin encore de simplifier les calculs qui suivent, nous supposerons que les forces d'excitation sont harmoniques" ("In order to simplify the ensuing calculations even further, we shall take the excitation forces as being harmonic"). This time, the main stumbling block was not lexical ("simplify" is a cognate and a word of Latin origin for the French verb "simplifier", and expressing "the following/ensuing calculations" was no hardship for our researchers); the difficulty was in expressing the notion of "encore": "still"? "again"? "further"?
Checking the way Group I had managed to cope with the same semantic field in the rest of the article, it could be seen that only the use of “again” was relatively well mastered. The result was the remedial intensive teaching of adverbs expressing continued or repeated actions.

The articles by the two groups of researchers differ considerably in their use of GL and ML. The qualitative difference is perhaps more indicative of the two groups’ overall strategies, and nowhere is this difference more characteristic than in transitions between GL and ML. Group I’s uneasiness about GL is evident in passages like the following in which we (and the reviewer too) get the feeling of a dash towards a wrongly perceived all-explaining equation. As noted by the reviewer who scribbled in the margin: “I miss several steps here, e.g. what is ‘k’?”, the necessary intermediary steps and conventions have not been given in GL, the only possible way of conveying the information in this particular instance.

From the previous equations (8) we obtain new equations representative of the motion of the structure in the low frequency range. In the first stage, each model matrix is split into kept and lost modes associated respectively to parameters \(|q'j|\) and \(|q''j|\), i.e. masters and slaves. For substructure \(j\) we then have:

\[
\{X'\} = \left[\begin{array}{cc}
Z' & Z_j \\
\end{array}\right]
\left[
\begin{array}{c}
lq'j \\
lq''j \\
\end{array}\right]
\]

and for the whole structure:

\[
\{X\} = \left[\begin{array}{cc}
Z & Z_j \\
\end{array}\right]
\left[
\begin{array}{c}
lq\j \\
lq''j \\
\end{array}\right]
\]

When asked to develop and complete the faulty passage, Group I came up with an optimal version which I have translated as:

“We are seeking approximate equations obtained from the previous ones which would be representative of the structure behaviour in low frequencies. Each modal matrix on the right and left is partitioned into kept modes which will make up the truncated modal basis, and lost modes associated respectively to the generalised parameters \(|q'j|\) and \(|q''j|\), in which \(k\) relates to the kept modes and \(l\) to the lost modes. We shall call them respectively masters and slaves. For substructure ‘\(j\)’, we then have: (equations follow).

Not quite the same story.

If we had to draw a conclusion about the differences between “instrumentally motivated” and “integratively motivated” texts, or between traditional and communicative types of language-learning approaches on the basis of GL/ML use, we might say that Group I’s maximum avoidance of GL argumentation and maximum possible use of ML presented them with intrinsic and lasting inconveniences, as they were not acquiring new language skills and transferring them to new productions.

With the help of, among others, myself, both groups ultimately managed to have their articles published by the same journals which rejected them in the first place. As hard science NNS article writers are more prolific than their counterparts in, say, EST, at least in my institution, the two groups have
produced a new article each since they first approached me about the texts analysed in the present article. It seems no coincidence that Group I have met with another refusal from an anglophone journal on the same grounds as for their previous work, and that Group II's new production has been accepted with only minor changes to be brought mainly to the accompanying non-verbal documents.

Considerable work has been devoted to describing scientific language (Lackstrom, Selinker & Trimble 1970, 1972; Swales 1971, 1974, 1990; Trimble 1985; Alley 1987; Upjohn, Blattes & Jans 1991), but there is a borderline area between GL and ML in the scientific articles written by non-native users of English. What goes before, in-between, and after mathematical equations when these are considered, rightly or wrongly, to be the backbone of a piece of reasoning in a scientific article constitutes the “glue” between scientific reasoning and general explanation.

Table 4 lists the most frequently chosen introductory, intermediary and concluding language forms chosen by our two groups of informants to accompany their equations. Only the forms with an occurrence rate higher than one per cent have been selected in order to eliminate isolated, badly assimilated or “chance” expressions not representative of our writers’ habitual discourse. The selected forms, presented here in decreasing order of utilisation, account all together for more than 60% of the different ways of introducing, interspersing or concluding equation passages.

GL is mostly used as an introduction to or a hinge between mathematical forms, and practically never as a conclusion. Concluding forms in GL account for less than 5% of the total number of all recorded forms. The mathematical formula is, in the eyes of our researchers, the best and indisputable form of conclusion. This is particularly true of temporary or intermediary conclusions;

<table>
<thead>
<tr>
<th>Introductory</th>
<th>Intermediary</th>
<th>Concluding</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Equation) is written...</td>
<td>... when ...</td>
<td>...this is but (a possible/rough/etc. explanation)</td>
</tr>
<tr>
<td>We can write...</td>
<td>...we obtain...</td>
<td></td>
</tr>
<tr>
<td>Let us consider...</td>
<td>...we can (then) write...</td>
<td></td>
</tr>
<tr>
<td>(Equation) can also be written as follows:</td>
<td>..(is)(also) written as...</td>
<td>The complete solution: demonstration is to be found in (name of researcher)</td>
</tr>
<tr>
<td>We designate...</td>
<td>...eventually (then) becomes...</td>
<td></td>
</tr>
<tr>
<td>(Equation) leads to the following:</td>
<td>...so...</td>
<td></td>
</tr>
<tr>
<td>We then have what follows...</td>
<td>...on the other hand...</td>
<td></td>
</tr>
<tr>
<td>(no introd. form)</td>
<td>..can also be expressed as...</td>
<td></td>
</tr>
<tr>
<td>Which may be better ()</td>
<td>..with...</td>
<td></td>
</tr>
<tr>
<td>Expressed as...</td>
<td>..we assume...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>..and again...</td>
<td></td>
</tr>
</tbody>
</table>
only the final conclusion of the articles is exclusively written in GL. This observation also holds true for a majority of articles written by native or near-native users of the language in the two scientific domains concerned.

Without going into too much methodological detail, we can say that a few functions which apparently ML can do well are conveying the ideas of size, dependence/independence, imbrication, progression/regression, increase/decrease (regular or irregular, predictable or random), iteration, interruption and also concluding indubitably. These useful functions assumed by ML enabled our writers to steer clear of a few traditional pitfalls of English grammar like comparatives/superlatives (is bigger/smaller than) and prepositions/particles (is a function of, is included in, is equal to, is not present in, etc.). However, it is interesting to note that a number of local mistakes also stemmed from the stylistic necessity of using substitutes for mathematical symbols in GL (e.g. => replaced by the erroneous form “leads at”).

On the other hand, what ML apparently cannot do adequately (for publication) are introductions and transitions, and also the expressing of notions like co-ordination, subordination, causality, restrictive hypothesising, the presentation of the chronological unfolding of a process, the definition of the physical environment of an experiment or process (diagrams and other visual aids are used in this instance).

The topic of the respective roles of GL and ML is too big to be dealt with exhaustively in this study, but the analysis of the two articles suggests that the management of mathematical formulae within a specialised article is a useful touchstone to assess the degree of confidence felt by non-native users and their mastery of the GL used. In the present case, the researchers’ belief in the omnipotence and self-explanatory value of mathematical forms proved woefully unfounded.

**Conclusion**

The sensitivity to GL which is implied by the communicative approach derives naturally from the variety of oral and written language situations and functions taught. In the particular instance of Group II, their insistence on sticking strictly to English as a metalanguage during the debriefing sessions about their specialist texts was good evidence of their desire to make the most of the EST teaching environment. This attitude was, of course, also part of their general integrative motivation. Group II then proved to be more eager to expand their resources and take risks, especially when they chose to paraphrase, re-phrase or use circumlocations in their use of general language. In contrast, the writers in Group I proved to be first and foremost risk-avoiders; as instrumentally motivated learners they conformed to the message-adjustment overall pattern defined by Corder (1983) mostly because of their message-reduction attitude.

However, what the study also made plain was that both groups wanted mostly to simplify their message and chose to do so by spontaneously using avoidance strategies. Similarities between the groups were reminiscent of what Váradi (1980) has observed about communication strategies used orally:
extreme reduction of message (absolute reduction being topic avoidance), too many argumentative passages that read like a series of isolated statements (thereby justifying the reviewers’ judgements), and transitional jerkiness often caused by the sheer absence of transition forms.

Both articles contained similar numbers of extra- and intra-lingual errors (those originating from negative transfers from the native language and those attributable to difficulties belonging to English proper). The post-mortem of the articles also illustrated the fact that error-free communication was often achieved at the expense of abandoning the researchers’ optimal meaning.

Most of the assistance offered by me was of a post hoc remedial type only after considerable frustration had been experienced by the rejected NNS article writers. Only when full attention to the linguistic and stylistic requirements of the research article genre are fully identified before putting pen to paper or mouse to mouse pad will the EST teacher’s role change from practising post-mortems to helping to deliver healthy scientific discourse.

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References


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