International Journal of Asian Social Science
ISSN(e): 2224-4441
ISSN(p): 2226-5139
DOI: 10.18488/journal.1.2018.810.909.917
Vol. 8, No. 10, 909-917

URL: www.aessweb.com

PRELIMINARY INVESTIGATION OF ESL STUDENT WRITING IN ENGINEERING

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Article History
Received: 21 May 2018
Revised: 31 July 2018
Accepted: 14 September 2018
Published: 8 October 2018

Keywords
Move analysis
Laboratory reports
Macro-sections
Rhetorical moves
English as a second language
Genre-based study.

ABSTRACT

Given the importance of writing skills for communicating messages in the field of engineering, and the seemingly perpetual conflict between novice engineers' poor ability to write and the quality expected by employers, it is worthwhile to investigate student engineers' writing ability or experiences prior to their employment. This study thus aims to investigate English as a Second Language (ESL) students' writing in engineering studies. The objectives of the study are to (1) identify the genres of writing by ESL undergraduates in engineering studies, and (2) analyse students' laboratory reports for 'moves' typically identified in the genre. Students' written scripts were collected from various engineering courses within the mechanical, electrical, and electronic engineering programmes of a Malaysian public university, and identified by genre based on their structure and content. The preliminary finding suggests that the majority of the writings are laboratory and technical reports. Based on a 'move' analysis outlined for student laboratory reports in science and engineering (Parkinson, 2017) a total of 14 laboratory reports was analysed and 5 macro-sections were identified namely introduction, method, result, discussion, and conclusion. This differs from the 6 macro-sections found for engineering in Parkinson (2017) study. Although the number of moves identified was essentially similar, some steps were unavailable in the laboratory reports within these macro-sections. It is believed that findings from this genre-based study can have pedagogical importance in that it may help to enhance the writings of ESL students in engineering studies to reach a standard that may be more aligned to the accepted norms of laboratory report writing.

Contribution/ Originality: This study contributes in the existing literature by detailing common 'moves' found in ESL student writing of laboratory reports in the engineering field. Most analyses of moves for similar written genres in the engineering discipline have focused on the writings of native speakers of English.

1. INTRODUCTION

This paper discusses some preliminary findings of an on-going project which aims to create two corpora compiling the written discourse of Malaysian student and professional engineers in mechanical, electrical, and electronic engineering. The present study thus aims to provide an insight into the ESL students' writing with a focus on the following objectives: (1) to identify the genres of writing produced by the ESL students in their engineering programmes, and (2) to analyse ESL engineering students' laboratory reports for 'moves' typically

identified in the genre. The general interest in academic and professional writing in engineering stems from the increasing need for good communication skills as part of professional requirement in the 21st century workplace. Writing skills, among others, have been highly emphasized as pertinent to the field of engineering as engineers are required to engage in various types of writing including "writing emails, minutes, reports, project proposal, business letters, memos and presentation slides" (Rajprasit *et al*., 2014). Unfortunately, writing and engineering are often somewhat generally viewed as a dichotomy with little relevance to one another. There seems to be a continuing conflict between "engineers' technical capabilities and their written and oral communication skills" (Schneiter, 2003). As a data and product-driven field, engineering is often associated with hands-on activities rather than the act of writing to communicate messages. It is hardly surprising then that writing is often cited as a deficiency particularly so for novice engineers as commonly identified in surveys that involve employers and alumni of engineering programs as regards their ability to communicate, and their academic knowledge in preparation for employment in English native-speaking countries (Koehn, 1995) as well as in non-native speaking countries (Yusoff and Samah, 2013; Rajprasit *et al*., 2014).

In relation to the study's focus on academic writing, it is generally accepted that tertiary education, specifically one that is prior to employment is seen as playing an integral part to prepare students for real-world textual practices in the professional context. One such writing would be lab reports because of their pedagogical importance or prevalence as a scientific form of communication. Hofstein and Lunett (2003) highlight learning advantages from laboratory activities and assert their importance in tertiary level education, and thus it was felt that there is a need to look at the norms of students' laboratory report in the context of ESL writing. The general connection between academic writing and professional writing has led to an increase of particularly pedagogically motivated investigations into student engineers' writings at the tertiary levels with most aiming to improve students' ability to write (Schneiter, 2003; Nelson, 2004; Durfee *et al*., 2011). More recent studies have gone a step further by looking at empirical evidences (written scripts) of how student writings differ from writings produced by professionals in the industry (Conrad and Pfeiffer, 2011). Most of these studies, however, are done in western universities in which English is the only mode of instruction.

A significant and common pedagogical approach to study writing is genre analysis. It refers to the study of texts by analysing their shared "communicative purpose, textual purpose, and content" (Luzón, 2005). More specifically, in describing genre, Swales (1990) move analysis is often adopted. In a text, moves, which refer to "semantic and functional units of texts that have specific communicative purposes" (Biber et al. as cited in Parkinson (2017)) can be identified by looking at specific purposes and language characteristics within the text. These moves can be realized by one or more steps which are the alternative ways of achieving the move's purpose. While move analysis has been used for investigating an extensive range of genres including business letters (Pinto, 2002) and media texts (Bonyadi, 2012) much attention has been given to research articles (RAs) since (Swales, 1990) studies which in turn has in recent years given rise to the interest in students' technical and laboratory reports mainly due to their close proximity in terms of macrostructure (abstract-introduction-method-results-discussion-conclusion). There are, however, apparent dissimilarities between the aspect of writer-audience relationship of the former and that of the latter which is obviously written by students and targeted at academic instructors.

In terms of purpose, laboratory reports serve to report on experimental work (Parkinson, 2017). Such reports are one of the major writing tasks in almost all science subjects and the purpose of these reports is two-fold: familiarising students with scientific communication through academic instructions, and as a platform for assessing students' learning in the laboratory (Ranawake and Wilson, 2016). Parkinson (2017) conducted a move analysis on a set of 60 highly-graded student laboratory reports in science and engineering study derived from Gardner and Nesi (2013) corpus of British Academic Writing in English (BAWE). Rhetorical moves and common linguistic features were analysed with the former being compared with moves previously identified in empirical research articles (RAs) particularly in studies by Kanoksilapatham (2007); Swales (1990); Lim (2006); Ruiying and Allison

(2003) and Lorés (2004). While Kanoksilapatham (2007) investigated the moves in 4 macrosections from introduction, method, results, discussion, others investigated individual macrosections; Swales worked on introduction, Lim studied the method section, Yang and Allison looked at the results, and Lores focused only on the discussion section. Parkinson's findings revealed some significant differences in the realisation of moves due to the differences in writer-reader relationships and purposes of the two genres with laboratory reports serving a pedagogical purpose and RAs for presenting new research. A total 22 moves were identified in six macro-sections of the laboratory reports namely abstract, introduction, method, results, discussion, and conclusion as shown in Table 1. The details in terms of the frequency mean for each move were omitted as this is not related to the focus of the present study.

Table-1. Moves in laboratory reports

ABSTRACT
Move: A1 Stating aim
Move: A2 Introducing topic
Move: A3 Stating Method
Move: A4 Stating Result
Move: A5 Providing Discussion
INTRODUCTION
Move I1 Establishing topic
Move I2: Advancing hypothesis
Move I3: Introducing experiment
METHOD
Move M1: Listing materials
Move M2: Describing experimental procedures
Move M3: Detailing statistical/data-analysis procedures
RESULTS
Move R1: Restating methodolgy
Move R2: Announcing results
Move R3: Commenting on results
DISCUSSION
Move D1: Contextualising Discussion
Move D2: Interpreting results
Move D3: Stating limitations
Move D4: Making suggestions for improvements
CONCLUSION
Move C1: Summarising study
Move C2: Drawing conclusions/Making claims
Move C3: Noting limitations
Move C4: Suggesting further investigation/improvement

Source: Adapted from Parkinson (2017)

Besides RA articles, student technical reports and laboratory reports have received much attention particularly in genre-studies involving native English-speakers' writings. In ESL research, however, studies have been rather limited especially with regards to students' academic writing in the engineering field (Raus, 2005).

2. METHODOLOGY

Samples of written scripts by ESL undergraduate students of mechanical, electrical and electronic programmes were collected and described in terms of their genres mainly by assessing their format and contents. Student laboratory reports were then separated and coded based on Parkinson (2017) rhetorical moves and steps. The collection of reports involved ESL writers who were either in year 1 or 2 of their studies: 2 reports from the electrical and 12 from the mechanical engineering courses. These, however, unlike those used in Parkinson's study, were not controlled for their grades; given the small number of scripts collected thus far, the researchers were unable to be selective of the scripts. While Parkinson's selection of scripts were all written by individual native

English-speaking writers, the present study's collection of laboratory report involved some collaborative writing particularly for those derived from the mechanical engineering courses. Collaborative writing here refers to writings done collectively with one group of students producing only one piece of writing for certain sections such as the introduction and methodology. More specifically, individual writings for these reports were only available for the results and discussion sections.

3. RESULTS AND FINDINGS

Written Genres in Engineering Studies

The scripts collected from the three engineering programmes were sorted out according to genre based on their format and content. Table 2 shows the distribution of genre according to programmes based on the number of scripts collected and number of courses.

Table-2. Distribution of written genre in engineering studies according to programmes based on number of scripts and courses

Engineering programmes	Written Genre					
	Technical reports		Laboratory reports		Essays/ paragraphs on engineering topics	
Number of	Scripts	Course	Scripts	Course	Scripts	Course
Mechanical	5	1	12	4	3	1
Electrical	2	1	-	-	2	1
Electronic	2	1	2	1	-	-
Total	9	3	14	5	5	2

This preliminary finding suggests that there were only 3 genres of writing that are commonly assigned to and produced by ESL students in engineering studies. This early finding seems to differ from genres that have been identified in earlier investigations in educational institutions in the west where English is the only medium of instruction (Conrad and Pfeiffer, 2011). This is hardly surprising in an ESL educational context where written communication are often restricted to more formal and less 'communicative' forms of writings such as laboratory and technical reports as opposed to project-related emails, cover letters with reports and technical memoranda which were identified by Conrad and Pfeiffer (2011). Braine (1989) also found different types of written assignments alongside lab reports and research reports (technical reports) which are case study and summary of/ reaction to reading.

While we acknowledge that this data set is relatively small, it nevertheless shows that technical reports and laboratory reports are two genres that are typical in engineering studies as opposed to essays and other types of writing. This is similar to the findings from Conrad's corpus-based study in which lab reports and reports (technical) were found to be the top two genre of writing in civil engineering, as well as Braine (1989) study of the most common types of writing assignments in undergraduate sciences and engineering courses which found lab reports making up 70% of the total assignments.

Rhetorical Moves in Student Laboratory Reports

Prior to conducting the move analysis, the purpose of laboratory reports was established. They serve as a type of document that reports on experimental work (Parkinson, 2017). Out of the 14 laboratory reports, 7 are from the Engineering Laboratory 3 course (KNJ 2251), 4 are from the Engineering Laboratory 2 course (KNJ 1241), 1 from the Engineering Laboratory 4 (KNJ 2261), and 2 are from Digital Systems Applications (KNL 2272).

The 22 moves in the six macro-sections by Parkinson (2017) are listed in Table 1. For this study, only five of these which is introduction, method, result, finding, and conclusion will be used as guides. The abstract section is found to be non-existent in the present study's collection of laboratory reports. The 5 'move structure' was also found in Raus (2005) genre analysis of technical report writing in samples of engineering students' writing and in selected textbooks.

Table 3 displays the three moves in the introduction sections alongside extracts from the sample scripts. Move I1 is identified as obligatory by Parkinson and include claiming importance (Step 1) which is signaled by mentioning the word important or practical applications, and the review of literature (Steps 2 and 3). Step 3, referring to literature, however, was scarcely found in the laboratory reports as students' statements seem to be dependent on the present knowledge which is possibly provided by instructors, modules or textbooks without explicit acknowledgement of resource. Gardner (Parkinson, 2017) also found explicit reference to be commonly omitted. Step 4 in Move 11 is providing diagram/ graph/ equation and was only identified in some of the introduction sections of the reports depending on the nature of the courses.

Table-3. Moves and steps in laboratory report Introductions

Move: I1 Establishing topic	Examples
Step 1: Claiming importance	The temperature measurement is commonly used for recent research to help and maintain alternative energy… (KNJ 2251)
Step 2: Referring to known information	Different types of temperature measuring devices have a variation degree of response towards change in temperature. (KNJ 2251)
Step 3: Referring to literature	Halliday *et al.* (2001) stated to obtain angular acceleration experimentally, if t is the time taken for the string… (KNJ 1241)
Step 4: Providing diagram/graph/equation	$I = mr^2$ [$kg.m^2$] (KNJ 1241)
Move I2: Advancing hypothesis	…for the experiment on beam A, as the load attached, the value of reaction reading on channel 1 and channel 3 will likely (be) almost the same. (KNJ 1241)
Move I3: Introducing experiment	
Step 1: Stating purpose	This experiment defines the effective measurement of temperature, by using and calibrating thermocouple to explore characteristic in changes of temperature. (KNJ 2251)
Step 2: Describing procedures	Similarly, for settings C1, C0 = 0, 1, decimal value 1, input D1 is fed to the output. (KNL 2272)

Source: Based on Parkinson, 2017, p. 6

Similar to Parkinson (2017) finding, Move I2 for Advancing hypothesis was found to be scarcely used (e.g. using the word 'should' or 'likely'). Move I3, also deemed obligatory, includes 2 steps which are Stating purpose – done through the use of words denoting aims and suchlike, as well as Describing procedures which was claimed to be very frequently found. The former step was found in some of the students' writings, but the latter was lacking as procedures often appeared together with apparatus and thus should be identified as part of the Method instead except for reports in electrical engineering whose introductions are heavily described in terms of process/ procedure because of the focus on logic systems.

Table 4 details the three moves in the Method sections of the reports namely Listing materials, Describing experimental procedures and Detailing statistical/ data-analysis procedures. In Move M1, materials and equipment were commonly listed, a move claimed as usual in engineering reports (Parkinson, 2017). For reports in electronic engineering, possibly due to the nature of the course which focuses on systems, listing of material or equipment was neglected, and therefore only Move M2 was applied. This move was the most frequent move in the native English group of writers' reports and was also available in all ESL reports. While reports in mechanical engineering were written in past tense and passive voice, the ones from electronic engineering maintained the imperative verbs typically found in manuals. Parkinson also found a minority using imperatives in their reports. Step 2 for referencing of procedure and Step 3 for illustrating procedure with the use of diagram, were only found in the electronic engineering reports, also possibly owing to the nature of the course. For Step 4 in which writers provide background to the procedures, the procedures are justified in terms of intended outcomes. This was only found in some of the reports. Finally, in Move M3, Detailing statistical/ data-analysis procedures, how the data will be analysed are detailed in only a few reports, again suggesting assumed knowledge on the part of the audience (instructor).

Table-4. Examples of moves and steps in laboratory report Method sections

Move M1: Listing materials	**Staddle Valve, Manometer Tubes, Manometer Board…**
Move M2: Describing experimental procedures	
Step 1: Detailing procedures	Close water supply valve and venture discharge valve (KNJ 2261)
Step 2: Referencing procedure in laboratory manual/other source literature	Connect the circuit as shown in Fig 2.4 (KNL 2272)
Step 3: Illustrating procedure with diagram	Figure 2.4 (KNL 2272)
Step 4: Providing background to procedure	Then, the load increased gradually to obtain the engine parameters at different load conditions. (KNJ 2251)
Move M3: Detailing statistical/data-analysis procedures	With the module power supplies switched ON, obtain the truth table for the gate. (KNL 2272)

Source: Based on Parkinson (2017)

The results section consists of three moves namely Restating Methodology (R1), Announcing results (R2) and Commenting on them (R3) as shown in Table 5. Move R1 Step 1 for Listing procedures was only found in one report while none was found for Step 2, Justifying methodology. This may be mainly because the ESL writers were trying to avoid overlaps between Method and Result sections. In Move R2, Step 2 involving pointing to results with phrases such as 'the table shows', surprisingly very few of the reports were found to implement this step which contrasts the high frequency found in Parkinson's work on the native English corpus. Step 2, Displaying result, however, was found to be prominent in that it existed in all reports. It can be seen as the main way of announcing results with figures and tables assumed as being self-explanatory. The lack of Step 1 and the prominence of Step 2 may relate to the writer-audience relationship in that writers often assume the results are well-understood by the instructors. In Step 3, Reporting results, unlike in Parkinson's finding of this being frequent, this step seems to be almost negligible in all reports except those in which a standard question-answer template was provided by instructors or modules. This is mainly because there are often overlaps between the results and discussion section. In contrast, Step 4, Calculating results/ stating Chemical equation was found in about half the reports owing to the nature of many of the courses requiring calculations. Move R3 with Steps 1 and 2 for explaining and commenting on results respectively were absent except for reports from the electrical engineering course. This finding was hardly surprising considering that a majority of the ESL students' writings suggest a self-explanatory approach to reporting results through the use of figures or tables, with many of the steps in the results section identified in the discussion section instead.

Table-5. Examples of moves and steps in laboratory report Results sections.

Move R1: Restating methodology	
Step 1: Listing procedures	…when load is applied at both side to get the reaction of….. In this experiment, we used steel alloy beam to determine the reaction..
Step 2: Justifying methodology	None
Move R2: Announcing results	
Step 1: Pointing to results	Input states 0, 1 in Table 2.2 shows that Y3 is not active… (KNL 2272)
Step 2: Displaying results (figure, table, graph)	Present in most reports.
Step 3: Reporting results	The output at G1 is at logic 0 in all input conditions. The voltage level is also low compared to in Exercise 1.1. (KNL 2272)
Move R3: Commenting on results	
Step 1: Explaining results	When the module power supply is switch OFF, the resistance between test point (t.p) 1.13 and 1.14 is very high. (KNL 2272)
Step 2: Evaluating results	It shows that the connection between the t.p 1.13 and 1.14 is open circuit at IC1 pin 8. (KNL 2272)

Source: Based on Parkinson (2017)

The Discussion section, as illustrated in Table 6, has four inter-related moves which function together in "interpreting the results, explaining results in light of known information, in the light of how the experiment was carried out, and drawing conclusions from them" (Parkinson, 2017). In Move D1, Contextualising discussion, writers are expected to show knowledge of theory and ability to explain results based on the theory. Very few reports were identified as having this move as a majority implemented Move D2, Interpreting results instead. There are altogether 8 steps involved in Move D2 as illustrated in Table together with some examples. Move D2 Interpreting results was found to be dominant in the reports with most reports implementing all the Steps except Step 4, comparing results with literature and Step 8, drawing conclusion. The former was hardly surprising because of the nature of student laboratory report which often assumes an existing background knowledge on the part of the instructor, or a universally understood scientific knowledge as prescribed in lessons or modules relevant to their experiments. As for drawing conclusions, these were most often found in the conclusion section.

Table-6. Examples of moves and steps in laboratory report Discussion sections

Move D1: Contextualising discussion	"In this experiment, the theory of young's modulus is used, which is a material's resistance to elastic information" (KNJ 1241).
Move D2: Interpreting results	
Step 1: Restating methodology	Thermocouple were used as a sensor to obtain readings from 2 different elements… (KNJ 2251)
Step 2: Stating selected findings	…for Beam A, when 5.0N of load is hanged at the left and right of the beam, the reaction force at the middle of the beam is 7.50N. (KNJ1241)
Step 3: Interpreting results	…both temperature has similar accuracy and able to stabilize at the same temperature…eventhough both maximum temperature were significantly different. (KNJ2251)
Step 4: Comparing results with literature	None
Step 5: Displaying figure/table/graph/equation	Present in all reports
Step 6: Accounting for (un)expected/unsatisfactory results	Factors that may have led to discrepencies in the values and errors in the experiment is Environment factor such as vibration… (KNJ 1241)
Step 7: Substantiating results	It is because the electrical resistance of materials is temperature dependent. (KNJ2251)
Step 8: Making claims/Drawing conclusions	None
Move D3: Stating limitations	When recording the data, the interval between 2 readings were 10 seconds apart and it could confuse the person who records because the interval were short. (KNJ 2251)
Move D4: Making suggestions for improvements	The loads should also be weighed before applying on the flywheel apparatus. (KNJ 1241)

Source: Based on Parkinson (2017)

Move D3, Stating limitations, was found to be common in the reports and repetitive from earlier statements. Finally, Move D4 which involves making suggestions for improvements were found in a majority of the reports.

The conclusion section involves four steps: summarizing study (C1), drawing conclusions (C2), noting limitations (C3), and suggesting further investigation (C4), with three moves (Moves C2, C3 & C4) overlapping with some steps in the discussion section. As mentioned by Parkinson (2017) although uncommon in other scientific fields, conclusion appeared most frequently in Engineering laboratory reports. This is also true in the case of the present's study's collection of reports. An example of C1 is given here: "…after completing this experiment, students are able to differentiate and recognize the characteristics between EX-OR and EX-NOR circuits" (KNL 2272). Samples for moves C2, C3 and C4 are similar to those found in the Discussion section and are often recycled from earlier sections.

4. CONCLUSION

Preliminary findings from this study of ESL writing in engineering studies suggest that writing genres typically produced by students are laboratory reports, technical reports, and essays. Other writings as identified from earlier studies in native English-speaking countries which include other types of more 'communicative' writings such as memos and e-mails, were unavailable. This situation may change once a larger collection of writing is collected and compiled for this on-going corpus project. For the present study, it was found that laboratory and technical reports are two major writing genres for students. Therefore, an analysis of rhetorical moves based on Parkinson (2017) work on laboratory reports in Science and Engineering was conducted on 14 student laboratory reports. While the number of moves were essentially similar, there seems to be a slight difference between the steps in the report writing employed by the native English-speaking engineering students, and those done by the ESL group in the present study with the latter showing less overlaps between micro-sections; for instance between Step 8 on drawing conclusions that has been left out in the Discussion section would preferably be placed in the Conclusion section. Out of the 6 macro-sections identified by Parkinson (2017): abstract-introduction-method-results-finding-conclusion, abstract was the only section that was not found in the ESL laboratory report writing. Due to the small number of scripts or sample collected from a limited number of courses, these findings cannot as yet be taken to be representative of ESL student writing in engineering studies. These findings, however, has the potential to be used as a guide to enhance the writings of ESL students in the engineering field to be more at par with what may be considered as the norms in the writing of laboratory reports.

Funding: This study received no specific financial support.
Competing Interests: This study forms part of a corpus-based project funded by Universiti Malaysia Sarawak under the university's MYRA Special Grant Scheme (C02/SpGS/1558/2017).

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