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Putting knowledge gained into practice in civil engineering lab reports

Wan Farah Wani Wan Fakhruddin^a, Anie Attan^{b*}

^{a,b}*Language Academy, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia*

Abstract

A large number of studies have established that learning to write in the second language and in particular, learning to write in the second language academic context require the development of advanced foundation. Without such foundation, writers simply do not have the range of lexical and grammar skills required in academic writing (Berkenkotter & Huckin, 1995; Chang & Swales, 1999; Hinkel, 2004; Paltridge, 2001). In the case of writing in the civil engineering lab reports, students are required to show their critical evaluation of a particular concept being discussed by providing relevant discussions and justifications from the experiments conducted with findings of literature and results obtained by others. Therefore, students not only have to be equipped with sound technical knowledge but also the linguistic knowledge to enable them to successfully realise such demands. Since civil engineering students are constantly expected to communicate with people from various fields both in oral and written forms by various means of communication, it is essential that students be explicitly taught on the linguistic features that are expected in the lab report writing. Seven good samples of civil engineering student writers' lab reports were gathered and analysed from two fields of the civil engineering (soil and geotechnical lab and structure lab) in an attempt to investigate the prominent linguistic features of the civil engineering lab reports. Additionally, interviews with the experienced content lecturers were conducted to obtain better insights on their views on the nature and the writing process of civil engineering lab reports. Findings of the study will be useful in an attempt to gain a better understanding of the discursive practices of the civil engineering community to allow opportunities for effective teaching strategies for academic and professional purposes. Implications drawn could provide students, teachers and the discourse community with essential and relevant information for more effective and better use of the language in the discipline.

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* Corresponding author. Tel.: +6-019-434-6364; fax: +603-2615-4212.
E-mail address: wanfarah@ic.utm.my.

The use of English as a medium of instruction in tertiary education especially in Malaysian universities is seen as a progressive step towards internationalisation of academic excellence in research and education as well as a preparatory step for students to be adept in both academic and professional fields. Students are not only expected to gain knowledge in their content subjects relevant to their discipline but also to show their understanding of the subject matter in their production of academic written work assigned by their lecturers. Such demands are apparent and reflected in the increasing requirement of written assignments, reports, papers, dissertations and examinations in English. In the pursuit of acquiring the desired skill of writing in the academic context, students in particular are facing the most difficult transition from writing for general English use to writing in the academic context particularly among engineering students which involved producing a large number of written academic texts that are often scientific in nature. Halliday (2004) discusses that scientific discourse involves various forms of discourse in which the activities of ‘doing science’ are carried out and that it integrates ‘theoretical technicality with reasoned argument’ often realised through its explicit technical terminology, taxonomies and proper use of technical grammar (Halliday, 2004, p.127). In the engineering field, its primary concern lies in the production of useful objects and materials. Nevertheless, the nature of engineering work involves both working with machineries and producing written documents. Some of the common elements in engineering writing include informing readers of the reasons, means, results and conclusions of the subject being reported. One of the common types of technical writing students need to perform in their study is the laboratory report. Under lab conditions, students use instruments which are materialisations of previous knowledge in which it requires students to translate physical objects into written data which can then be manipulated and studied by others. Knorr (1985) pointed that in the laboratory, ‘texts’ are provided by ‘constantly accumulated combinations of measurement traces (graphs, figures, printouts, diagrams, tables, etc) which will later be interpreted in order to be regarded as engineering knowledge’ (Knorr, 1985, p.352). Writings of lab report for diploma students taking civil engineering programme are collective efforts of students working and writing lab reports in groups of three to four. Although such collective efforts can be seen as an easy task to perform, most of the students have little or no formal exposure in producing good lab reports which result in the inability to describe procedures and findings appropriately as the skills are not explicitly taught to them in their studies prior to their actual lab report writing. Due to their lack of knowledge on the requirement of the task, students have little knowledge of what is expected of them particularly on the linguistic conventions of lab report writing. Although English courses are made obligatory for all university students, it was found that the courses have not been successful in dealing with the problems faced by students in academic writing especially when addressing the linguistic demands of the task assigned.

This study aims at answering the following questions:

- 1.1 What are the generic stages of lab report writing in the civil engineering field?
- 1.2 What are the linguistic features that realise the stages involved in the civil engineering lab reports?

1. Characteristics and Approaches to Genre Analysis

Swales (1990) defines genre as ‘a class of communicative events’ and that it comprises ‘not only the discourse itself and its participants, but also the role of that discourse and the environment of its production and reception including its historical and cultural associations’ (Swales, 1990, p.46). Genre is also described by Tribble (1996) as ‘a communicative vehicle’ that is used to achieve writing goals among a discourse community. Those who frequently use specific genre in their writing routine in the target discourse community will have a better knowledge and understanding of the writing conventions

compared to those who use them occasionally as they are better at differentiating the conventions used for specific types of genre. As pointed by Swales (1990), the main notion underlying genre is the communicative purpose in which it shapes and determines the internal structure of the genre acquired from the specific members of the discourse community as a result of their constant contact, experience and training within the specific community. Apart from determining the internal structure, the communicative purpose of a genre also decides the choice of words and sentences within the text (Swales, 1990). However, the use of linguistic resources in writing needs to conform to the standard practices within the specific genre as noted by Bhatia (1993) who emphasised that each genre is successfully realised by specific communicative purpose that uses 'conventionalised knowledge of linguistic and discursal resources'. In order to achieve the communicative purpose of writing lab reports, student writers need to learn not only its rhetorical structure but also its linguistic features in order to write lab reports that conform to the practices of the discourse community. In order to understand and analyse a particular genre, there are three main approaches that can be used in the area of applied linguistics (Hyon, 1996). The three traditions are the Australian 'Sydney' school of genre theory represented by Martin (1992), the North American Rhetoric studies represented by Miller (1984) and Freedman & Medway (1994) and also English for Specific Purposes (ESP) represented by Swales (1990). The differences among the approaches reside in their focus on either the textual forms or the social practices. This study will describe in detail on the Sydney school approach as this study uses this approach to obtain the results of the study. The theory behind the Sydney school genre approach rests behind the systemic functional theory particularly the works of Halliday (1994), Hasan (1996), Martin (1992) and Matthiessen (1995). The main focus of this approach is on the schematic structure of different genre types that include two contextual variables which are the genre and the register in which the genre is seen as being related to the social purpose in using language and as an instrument that captures the schematic structure of the text realised in the form of stages. This approach aims at developing students' metalinguistic awareness about the schematic and language resources that can be used to present different generic purposes. In analysing a text genre, this approach assumes that the overall purpose of the text is met through observation of a number of related 'communicative events' and through 'a sequence of stages, each of which achieves an intermediate purpose' (Corbett, 2006, p.288). Analysing the register on the other hand assumes that textual features can be predicted as texts may vary conventionally in relation to three situational variables; i. 'field' which is the subject matter, ii. 'tenor' which is the relationship between participants in the interaction and iii. 'mode' which is the form of the text whether it is in written or spoken form. It is important to note that the situational variables do not account for the reason the text being produced either in written or spoken form. Genre analysis conducted following this approach can be made by observing a number of related communicative events. The analysis can be done by initially identifying the stages involved followed by determining their possible chronological order after which the analyst will arrive at the 'generic structure potential' of a set of communicative events of the text (Halliday & Hasan, 1989).

In view of the above, this study is interested in investigating the regularities in textual features which could result in a readily recognisable conventionalised form in terms of structure, generic stages and linguistic features of civil engineering lab reports.

2. Method of Analysis

2.1. Document study

Seven authentic civil engineering lab reports were collected from the content lecturers teaching the lab subjects (soil and geotechnical and structure labs). The samples obtained were gathered based on accessibility, availability and good ratings given by the content lecturers. Prior to performing each lab work, students are given a lab sheet by their lecturer which includes information on the title of the lab (e.g. Soil compaction test, soil consolidation test, etc), introduction, objective, equipment, theory and the procedures for the experiment. Apart from that, a table containing items needed to be calculated and measured are also given as a guideline for students to gather quantitative data as well as a few questions are listed in the lab sheet for students to critically discuss and answer in their lab reports. The time allocated for each lab session is two hours. While conducting the experiments, students are expected to record the results obtained as they are required to submit lab reports to the lecturer in which they will be given a week to complete the written report in about 12-15 pages for submission.

2.2. Eggins & Slade's (1997) six steps of principled genre analysis

The genre analysis of civil engineering lab reports was analysed to identify regularities in structure, generic stages as well as linguistic features. It was believed that such regularities are a reflection of the conventions used by the civil engineering discourse community when they use lab reports as a mode of communication. In this study, Eggins & Slade's (1997) six steps for a principled genre analysis was used to analyse the findings in which the steps proposed can be used to study and describe any genre regardless whether they are in written or spoken form. The six steps are presented in Table 1.

Table 1. Six steps of principled genre analysis (Eggins & Slade, 1997)

Step	Description
Recognising a chunk	A 'chunk' is a part, a segment or series of segments of a text that has a global or macro-structure.
Defining the social purpose of the chunk and labeling the genre	This step not only includes classifying the overall function of the genre and its name, but it also involves identifying the way the text type constructs social reality. In this step, we would define the social practices the text refers to, and the attitudes and values formed by and reflected in it.
Identifying and differentiating stages within a genre	Stages are constitutive elements of genres. They can be identified through the use of functional labels.
Specifying obligatory and optional stages	The obligatory elements are defining of the genre and they are key elements in recognising a genre. Optional elements are not defining features and can occur across genres.
Devising a structural formula	This includes writing down the stages in a linear sequence, together with some notation that would show their ordering and whether they are obligatory or optional. In Eggins & Slade's (1997) notation — widely used after Hasan's (1984) analysis of nursery tales and service encounters — the symbol ^ denotes order of the stages with respect to each other, and stages enclosed in parentheses are optional. For example, a structural formula for narratives would read: (Abstract) ^ Orientation ^ Complication ^ Evaluation ^ Resolution ^ (Coda).
Analysing the semantic and lexico-grammatical features for each stage of a genre	Lexico-grammatical choices (of words, linguistic patterns and discourse characteristics) will differ across genres, but also across the different functional stages within a given genre.

Overall, Eggins & Slade's genre analysis structure includes three basic steps: i. identifying the genre, ii. finding a structural formula that will represent most instances of the genre and iii. analysing the linguistic characteristics of each stage. In order to achieve the main objectives of the study, Step 4 (Specifying obligatory and optional stages) and Step 6 (Analysing the semantic and lexico-grammatical features of each stage of a genre) were particularly highlighted. In addition, frequency count was also included to indicate the significant findings of the study

2.3. Semi-structured interview

The study also involved interviews with two experienced content lecturers who have been teaching and supervising the lab work in an attempt to gauge their feedback as they are the immediate discourse community members in which the students are in direct contact with. This allows a better understanding of the civil engineering community's conventions of writing lab reports as it was found that similar writing convention of lab report used at the university is also used by those in the professional field as well as in other higher learning institutions. Questions asked in the interview probed into examining the nature of the lab report writing task, lecturers' expectations and views on students' lab reports and their views on writing in the civil engineering discipline.

3. Generic stages and linguistic features of civil engineering lab reports

3.1. Overview of the genre of lab reports on soil and geotechnical and structure

The structural formula for Soil and Geotechnical lab work is:

Stages:

*Title page ^ Introduction ^ Objective ^ Theory ^ Equipment ^ Procedures ^ Results ^ Data Collected
^ Calculation ^ Question ^ Answer ^ Conclusion ^ References ^ Attachment*

The structural formula for Structure lab work is:

Stages:

*Title page ^ Introduction ^ Objective ^ Theory ^ Apparatus ^ Procedures ^ Results ^ Data Collected
^ Calculation and Results ^ Question ^ Answer ^ Conclusion ^ References ^ Attachment*

For both types of lab reports, findings showed that all the stages included are obligatory stages which have been predetermined by the faculty in their expectations on students' lab reports in which failing to include any of the stages will cause deduction of students' marks. There are no recursive and optional stages for both types of lab reports as every stage needs to be written in sequence.

3.2. Generic stages of civil engineering lab report on soil and geotechnical and structure

Based on the analysis of the lab reports, the generic stages involved in the civil engineering lab reports as well as the function of each of the stage was identified. The generic stages as well as the functions of the stages are presented in Table 2.

Table 2. Generic stages of civil engineering lab report on soil and geotechnical and structure

Stage	Function
Title page	To indicate the students' group and acknowledge the type of lab work conducted
Objective	To point out the main objective of the report
Introduction	Hypothesis is made which include background information of the experiment, a brief summary of how the experiment was performed, the findings and conclusion of the investigation
Theory	Present relevant theories pertaining to the experiment conducted
Equipment/ Apparatus	List every item that is needed to conduct the experiment
Procedures	Describe all the steps performed and completed during the experiment
Data collected	Write the numerical data obtained from the procedures conducted
Calculation	Provide the calculation for each of the item required for the experiment
Result	Provide the result obtained from the experiment performed
Question	Questions are posed for students to answer
Answer	Discuss and answer the questions given in the lab sheet
Conclusion	Summarise the entire process of the experiment conducted
Reference	Acknowledge other people's work referred to in the lab report
Attachment	Attach pictures and diagrams of the work performed in the experiment

3.3. Linguistic features of civil engineering lab reports

The objectives of writing lab reports as outlined by the civil engineering faculty are: i. to strengthen and relate fundamental theories with laboratory experiments, ii. perform laboratory experiments in the field of material, soil and geotechnical, structure, highway and traffic and environmental engineering and iii. analyse experimental data, relate theoretical aspects and write laboratory reports. In order to achieve these objectives, the lab reports produced by student writers share many features in common with other genres of formal writing such as those found in the professional and academic fields. Such features include the use of passive voice, nominalisation, sequential connectors, technical nouns and activity verbs. As will be discussed below, lab reports in the civil engineering field are characteristically marked by these features.

4.3.1 *Passive voice*

When writing the lab reports especially for the Introduction, Answer and Conclusion stages, it was found that the prominent grammatical feature is the passive voice. In the Introduction stage, the use of the passive voice occurred in most instances where students relate the knowledge and techniques used that are related to the subject being analysed. The passive voice usually occurs with mental verbs (have recognised, is known, is determined), communication verbs (is called, is termed, is advised), and activity verbs (is increased, is applied, are retained, is plotted, is obtained). On the other hand, the predictive modal is used in the Answer stage to indicate possible actions to be taken to address or encounter the problems related to the experiment (can be avoided, can be minimised). In this stage, the choice of active or passive voice is determined by the deictic element (we). With the presence of the deictic element, verbs that co-occur with it are in the active voice while those without the deictic elements will be written in passive voice. The passive voice is also used in the Conclusion stage to explain the hypothesis that can be made based on the findings of the experiment (are taken, cannot be increased). According to Biber et al (2009), the use of the passive voice is common in academic writing context and that many of the common instances of passive verbs refer to scientific method and analysis and is commonly used when stating a fact that is known by people in the discourse community and emphasising the key concept that is related to the subject being discussed. The human factor is not particularly important in academic writing as the passive voice gives ‘the status of topic to the direct object of the corresponding active voice clause’ (Biber, 2009, p.168).

4.3.2 *Nominalisation*

Another prominent grammatical feature of civil engineering lab reports is the use of nominalisation throughout the entire report when referring to a particular concept (compressibility, reduction, consolidation, compaction, saturated, reactions) particularly in the Introduction stage. Based on the results obtained, it was found that nominalisation is frequently used by student writers when referring and explaining about a particular concept apart from using technical and concrete nouns when giving explanation. This lexical category is formed from the conversion of verbs and adjectives into nouns to reflect abstract concepts (compressibility, consolidation, compaction). The co-occurrence of these features help students in their attempt to highlight some background information that are relevant to the lab work conducted. Most importantly, the use of nominalisation in the lab reports allows student writers to be precise and specific about the topic that they present in their writing.

4.3.3 *Technical and compound nouns*

In line with the technical discipline that is being investigated, it was found that civil engineering lab reports use a significant amount of technical and compound nouns in the lab report writing especially in the Introduction, Objective, Theory, Equipment/Apparatus and Procedure stages. In the Introduction stage, in order to highlight the knowledge and technique used when performing the lab experiment, technical nouns are used (density, clay, soil, energy, curve, mass, beam, etc) as well as compound nouns (unit weight, air void, moisture content, pore water, clay sample, soil particles, continuous beam). Compound nouns are also used in the Objective stage for a similar purpose (soil sample, moisture content, laboratory conditions, portal frame, horizontal deflection, applied load). In the Theory stage, technical nouns are used to indicate specific theory, equipment or item used in the procedure (Standard Proctor, Modified Proctor, compression index, fine-grained, static loads, cylindrical sample, standard

data, oedometer test, etc). In the Equipment/Apparatus stage, compound nouns are used to highlight the knowledge and technique used when performing the lab experiment (weighing machine, base plate, metal ring) while in the Procedure stage, compound nouns are used to indicate the lab procedure (dial gauge, Standard Proctor, soil sample, etc). Based on the feedback obtained, it was found that content lecturers prefer lab reports to be written in brief and as concise as possible to avoid unnecessary confusion and lengthy details. The content lecturers interviewed further commented that the writing should be straightforward, self-explanatory and can be understood by everyone who reads it.

4.3.4 Action/Activity verbs

Due to the nature of lab report writing that is to relate, perform and analyse the results obtained in the lab experiment with relevant theories and other findings, the use of action or activity verbs are prominent throughout most of civil engineering lab report stages (prepare, mix, compact, measure, obtain, distribute, trim, remove, apply, compute, etc). It was found that all the sequences of the Procedure stage started with action verbs and was written in an active voice without any mention of the doer of the subject such as 'you', 'we' or 'I'. In addition, the use of active voice in the Procedure stage helps students to improve student writers' writing in terms of clarity and conciseness. Apart from using action and activity verbs to explain the lab procedure, it was found that they are also used in the lab sheet rubric to indicate specific task students need to perform in the lab work (plot, determine, describe, discuss, illustrate, etc). The use of action and activity verbs in lab sheet rubrics and question stems (discuss, describe, etc) requires student writers to elaborate on their views regarding the subject being discussed thus expecting them to draw upon their background knowledge surrounding the topic and examine the various reasons for and against the topic being discussed.

4. Conclusion

Based on the overall findings and analysis conducted, it was found that civil engineering lab reports involve 14 obligatory moves (Title page, Introduction, Objective, Equipment/Apparatus, Theory, Procedures, Result, Data collected, Calculation, Question, Answer, Conclusion, Attachment and Reference). All these stages serve specific purposes to both the students and lecturers who are immediate members of the civil engineering discourse community in which students are in close contact with. As validated by the content lecturers, the generic stages identified in the study are also commonly and widely used by members of the discourse community in other institutions and in the professional fields. As discussed by Schleppegrell (2005), the evaluation of the outcome of the experiments from a linguistic perspective is 'the most challenging part of the lab report' (p.179) as students are required to use the language to interpret their results and 'locate them in relation to the theoretical assumptions that they made' when conducting the experiment. In order to successfully relate the theoretical assumptions with the findings of the experiment, Schleppegrell argues that students need 'a nuanced use of language to present a clear interpretation of results (p.179) and that it is a challenging linguistic task that cannot be successfully realised without 'control of the range of grammatical resources that enable such presentation (p.179). Prominent linguistic features of civil engineering lab reports include several grammatical and lexical features. Firstly, the use of passive voice is apparent throughout the lab report. Walker (1999) pointed that using the passive voice appropriately in writing lab reports indicates 'an experienced engineering persona' and that failing to do so will give an indication to the lecturers that students 'have not adequately internalised the principles of focusing on lab activities rather than on the actions of the agents' (p.14). Another prominent linguistic feature is the use of nominalisation. As pointed by Martin & Rose (2007), nominalisation is part of the phenomenon of grammatical metaphor 'in which a semantic

category such as a process is realised by an atypical grammatical class such as a noun, instead of a verb' (p.106). Nominalisation also allows students to perform 'information packaging' and that when it is used to discuss a particular concept, it makes it possible for writers to build up 'chains or sequence of logical argument' (Halliday, 2008, p.152) thus allowing writers to present their argument and reasoning that would be able to be presented in a concise and specific way. Other prominent linguistic features are the use of technical and concrete nouns and activity and action verbs. Engineers are known to be straightforward and concise in their writing. Therefore, the frequent use of these features show that students are also exposed to the style of writing that is concise, straightforward and specific. Elimination of lengthy description and unnecessary details from their writing shows that the civil engineering field place particular importance on conciseness and specificity in writing. Overall, a good civil engineering lab report will be able to highlight and show students' understanding of the reports as well as the findings which is realised by providing evidence of sound knowledge of the content and key concept discussed apart from highlighting similarities and differences of result findings obtained from the experiment with other findings from different sources. Although language is not a key consideration when lecturers assess the students' written work, the content lecturers agreed that language does play a pivotal role in writing of lab reports as the appropriate use of the language will allow students to demonstrate their problem-solving, critical thinking and technical skills in their piece of writing in order to ensure the success of students in becoming better civil engineers once they venture into the professional world. The genre analysis of civil engineering lab reports has provided us with an insight of how the knowledge gained by the students in the course of their study is utilised in an attempt to evaluate students' understanding on the subject matter. In the case of civil engineering lab report, students are tested on their knowledge and understanding of key concepts pertaining to the specific sub-field of civil engineering as well as their maturity in arguing and discussing and putting forth their opinions on the subject matter through appropriate use of the language. In an attempt to help facilitate students in understanding the nature of the lab report writing, it is thus necessary for students to be prepared and guided on the relevant and appropriate use of rhetorical and linguistic strategies in this kind of genre as well as for other genres. If students are able to justify why a particular genre is used and written the way it is supposed to be written, they will be able to successfully construct a genre in a discourse community in which it is routinely used. Such instances represent students' thorough understanding of the rhetorical and linguistic demands of the genre that they are required to be familiar with and therefore are on their way to becoming better writers and be part of the discourse community.

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