



# English relative clauses in science and engineering journal papers: A comparative corpus-based study for pedagogical purposes



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## HIGHLIGHTS

- We examine how English relative clauses are used in science and engineering journal papers.
- Results show the frequent use of relative clauses, and high frequency of non-restrictive clauses.
- Extremely high use of 'that' over 'which' for restrictive relative clauses is also found.
- Some tips for teaching English relative clauses are provided for pedagogical purposes.

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## ABSTRACT

This corpus-based study presents how English relative clauses are used in science and engineering journal papers. Relative clauses ensure semantic clarity and textual variety but they cause difficulty to non-native speakers of English due to their diverse uses and functions. With pedagogical purposes in mind, this research investigates how frequently and in what context relative clauses are employed in three representative science and engineering journals, namely *CELL*, *Journal of American Chemical Society*, and *IEEE Journal of Solid-State Circuits*. In addition, relative clauses used in papers of *English for Specific Purposes* are investigated and compared with those in the science and engineering journal papers, to reveal the similarities and differences between them. Some unique features of relative clauses used in science and engineering journal papers are identified, such as the frequent use of relative clauses, the high frequency of non-restrictive relative clauses in the papers of *Journal of American Chemical Society* and *Journal of Solid-State Circuits*, the high proportion of 'prepositions + which,' and the extremely high use of 'that' over 'which' for restrictive relative clauses. Pedagogical suggestions are provided to help science and engineering paper authors and ESP/EAP practitioners use and teach relative clauses in an efficient way.

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## 1. Introduction

Writing and publishing academic journal papers has become a significant mission of graduate students and professors in Korea. The situation has been sparked by social pressure and the mass media's evaluation of the universities, leading to harsh competition among them (Cho, 2012). Universities in Korea are now very concerned with this evaluation, one index of which is the research capacity of a university, mainly assessed by the number of papers published in international journals. When it comes to science and

engineering fields, the effort made to publish papers in international journals with a high reputation is doubled as research groups in other parts of the world are likely to conduct similar research. A need for the publication of journal papers is accelerated since some science universities in Korea demand graduate students to publish their papers in international journals with a high impact factor as a graduation requirement. Writing journal papers for publication, however, burdens Korean graduate students and faculty members working in the fields of science and engineering as most prestigious journals in the fields are published in English. While working to publish papers, graduate students and faculty members of the country felt that they were put at a disadvantage, compared to those working in English-speaking countries, where more resources are available to assist journal paper authors (Cho, 2009a). The disadvantage that non-native speakers of English have felt

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when writing journal papers was found to be universal across countries. Cases researched in other ESL/EFL settings such as Hong Kong (J. Flowerdew, 1999a, 1999b), China (Li, 2006), Poland (Duszak and Lewkowicz, 2008), Venezuela (Salager-Meyer, 2008), Sudan (El-Malik and Nesi, 2008), and Italy (Giannoni, 2008) have revealed similar findings.

In ESL/EFL settings, many graduate students in science and engineering fields do not have adequate English proficiency and training for paper writing, which may result in the delay of paper publication and decrease the chance of papers being published. Under these circumstances, it is imminent for ESP/EAP practitioners and English teaching faculty to train graduate students with materials developed for them. Part of this task is identifying features targeted for teaching and analyzing their attributes through the investigation of published journal papers. Of the several components comprising journal paper writing, linguistic features such as sentence structure, vocabulary, and grammar need to be addressed more as they are perceived to be more difficult and problematic to non-native graduate students than meta-linguistic features such as overall organization and paragraph structure (Casanave and Hubbard, 1992; Cho, 2009a; Dong, 1998). Research has disclosed common grammatical features of English in science and engineering journals: diachronic evolution of referential behavior in medical articles (Salager-Meyer, 1999), signaling nouns in written biology corpora (J. Flowerdew, 2003), construction of stance through nouns followed by *that* in materials science (Charles, 2007a), verbs in reporting clauses used in citations of materials science (Charles, 2006), word frequency and distribution used in medical research articles (Chen and Ge, 2007), and use of participial and relative clauses in two science journals, namely *Cell* and *Physical Review Letters* (Cho, 2009b; Cho and Kim, 2009).

With pedagogical purposes in mind, this study focuses on English relative clauses used in science and engineering journal papers since they play a key role of ensuring semantic clarity between clauses and promoting syntactic maturity as well as textual variety. Relative clauses, however, are considered one of the most difficult areas of English for non-native speakers of the language to master, due to differences between English and their mother tongue, and the complex grammatical attributes such as restrictive or non-restrictive clauses, human or non-human head nouns, the position of prepositions in relative clauses, the zero-relative pronoun, etc. This study investigates relative clauses used in the papers of three representative science and engineering journals, namely *CELL*, *Journal of American Chemical Society*, and *IEEE Journal of Solid-State Circuits*. The investigation is expected to reveal features of relative clauses unique to science and engineering journals. In addition, relative clauses used in the papers of *English for Specific Purposes*, a journal in a different academic discipline, are probed to disclose differences and similarities of relative clauses used in science and engineering journals and a language research journal.

## 2. Literature review

### 2.1. Relative clauses in English

Relativization in languages is a process through which one sentence is embedded in another sentence when the two sentences share the same referential noun or noun phrase (Abdolmanafi and Rahmani, 2012). An English relative clause functioning as an adjective and combining separate clauses modifies a noun or noun phrase in the main clause, helping ensure semantic clarity between clauses. It also promotes syntactic maturity and textual variety, as claimed by Kameen (1978, 1983). He stated that the length of a T-unit, a main clause along with all the other subordinate clauses embedded within it, is one of the decisive factors to differentiate

good and poor writers. In this regard, relative clauses, which increase T-unit length, could be a significant grammatical feature to teach for a better quality of writing. Technical writing textbooks, in fact, recommend the use of complex sentences rather than the repeated use of simple sentences (Markel and Holmes, 1994; Weisman and Collins, 1998), and suggest combining related ideas using relative clauses (Lannon, 1988).

Relative clauses, however, are considered one of the most problematic and difficult areas of English (Marefat and Rahmany, 2009) to non-native speakers due to grammatical differences between their mother tongue and the English language, such as the position of relative clauses with respect to the head noun, the ways for relative clauses to be marked, and the presence of a pronominal reflex, and the complex grammatical features such as restrictive or non-restrictive clauses, human or non-human head nouns, zero-relative pronoun, and position of prepositions in a relative clause. A pioneering study of relative clauses of non-native speakers of English by Schachter (1974) clearly showed the problems that non-native speakers were likely to undergo in their writing. Japanese and Chinese students, whose native languages differed from English in terms of the position of relative clauses, avoided using relative clauses in their writing, thus producing significantly fewer relative clauses, while Persian and Arab students, whose mother tongues had the same postnominal relative clauses as English, produced about the same number of relative clauses in their writing as their native speaker counterparts. Yip and Matthews (1991) also found avoidance strategies of relative clauses of Hong Kong students with a Chinese language background. Chang (2004) was in line with the previous research stating errors made by Chinese ESL learners were caused by L1 transfer. Other language learners of English were found to adopt L1 language transfer and avoidance strategies when producing English relative clauses. The production of English relative clauses of Korean learners of English (Park, 2000), Japanese learners of English (Miura, 1989), Hong Kong learners of English (Bunton, 1979), Thai learners of English (Phoocharoensil and Simargool, 2010), and Persian learners of English (Abdolmanafi and Rahmani, 2012) was affected by their L1.

However, it must be noted that other factors, such as the overall English proficiency of learners (Chiang, 1980) and different data elicitation methods (Liu, 1998), affected the avoidance and general production of relative clauses. Baek (2012) investigated the processing of relative clauses by Korean L2 learners and witnessed that the processing behaviors of English relative clauses of Korean L2 learners were quite similar to those of native-speakers, indicating that L1 transfer did not occur in the processing of English relative clauses by Korean learners.

In a different spectrum of research on English relative clauses, investigation on difficulty order has been conducted. Keenan and Comrie (1977) proposed a noun phrase accessibility hierarchy hypothesis, in which a head noun functioning as a subject in the relative clause is most accessible or easiest to process while the object of comparison is least accessible or most difficult to process. They detailed the hierarchy as follows:

SU > DO > IO > OBL > GEN > OCOMP

where SU stands for a subject, DO for a direct object, IO for an indirect object, OBL for a major oblique of a noun phrase, GEN for a genitive and OCOMP for an object of comparison. The hypothesis of accessibility hierarchy has sparked investigation on the issue. Gass (1979a, 1979b), from a language transfer perspective, investigated the hypothesis and claimed that the production of relative clauses by non-native speakers of English was able to be predicted by the hierarchy theory, with the exception of the genitives. The theory, however, as time passed, has lost its universality as other languages

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