

Title	アカデミックライティングにおける修正スキル向上のためのコーパスを利用した適応的ツール：TRONAの場合
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Citation	
Issue Date	2018-09
Type	Thesis or Dissertation
Text version	ETD
URL	<a href="http://hdl.handle.net/10119/15525">http://hdl.handle.net/10119/15525</a>
Rights	
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学位の種類	博士(情報科学)		
学位記番号	博情第 393 号		
学位授与年月日	平成 30 年 9 月 21 日		
論文題目	A Corpus-based Adaptive Tool to Improve Revision Skill in Academic Writing: The Case of TRONA (Topic-Related revisiON Assistant)		
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## 論文の内容の要旨

Academic writing occurs in the final phase of a research activity cycle, where students present the results of their research. Students and researchers in higher education measure their achievements through the number of quality research articles that they publish. Therefore, studying how to improve the quality of writing is an important area of research. Quality writing is required in research in order to convey ideas clearly, especially when students write research articles or dissertations.

Writing is a cognitive activity consisting of generating, translating and revising. Much of the research in the area of academic writing tools is focused on equipping students with grammatical skills (especially in the case of English as a second language) and technical writing skills. Some of the tools also assist students with the generating stage (idea generation, planning etc.). However, there is not much research on the use of software tools to assist students during the revision process of academic articles. This is the motivation for this dissertation to focus on the revision aspect of the writing process.

This research designed and implemented a corpus-based adaptive tool, TRONA (Topic Related revisiON Assistant), to support the improvement of revision skill in academic writing. The revision corpus consisted of articles written by former students in one laboratory and it included the raw drafts as well as the final articles, and the feedback from the laboratory supervisor in the form of comments that helped those students improve their drafts. Natural language processing and machine learning techniques were applied to reliably predict the most important comments. These comments were used to provide adaptive support in the form of hints to help students resolve reviewer comments in their own article drafts.

The type of hints provided depend on the student's skill level. The type of adaptive support given is based on the teaching methods of the cognitive apprenticeship theory: specifically, modeling, coaching, scaffolding and fading. The cognitive apprenticeship theory is a widely accepted pedagogical theory of teaching cognitive skills in an explicit way. Through the adaptive interface, novices are provided with modeling support,

intermediate students with coaching, while the support for advanced students fades so that they can become more independent.

The Item Response Theory (IRT) was applied to estimate the student's revision skill and the comment difficulty. The estimated student revision skill score for 7 students and the comment difficulty measure for 20 comments by IRT was compared with a manual evaluation by a supervisor of the laboratory. The Pearson's correlation analysis results showed a significant correlation between the student scores by IRT and supervisor estimations.

Furthermore, a machine learning algorithm (SVM) was applied to classify the comments in the article drafts in the corpus as *content-related* (comments that encourage global revision) or *not content-related* (comments on simple spelling and grammatical errors). With performance measures of 89% that were achieved for both recall and precision, it was demonstrated that machine learning can be applied to automatically and reliably predict whether a reviewer comment in an academic article is content-related or not. Once a student uploads their document to TRONA, about 90% of the *non content-related* comments can be filtered out. The student can therefore first focus on revising the comments that encourage global revision. The classification method was also incorporated into TRONA to select the content-related comments that were applied in the Item Response Theory to estimate the students' revision skill level.

The contribution of this research is in the area of writing tools that use artificial intelligence to support the revision process of students in higher education. This study presented a way to construct a revision corpus of raw article drafts from previous students in one laboratory, as well as a way of using machine learning, to make the reviewer comments in the drafts more meaningful to the students' revision process. The Item Response Theory was proposed as a suitable method to estimate students' revision skill. In addition, this study demonstrated how to achieve adaptation in a revision support tool through the cognitive apprenticeship methods of modeling, coaching and fading. Acquisition of revision skill is highly dependent on the laboratory style of writing; therefore this research could have an impact on laboratory education.

**Keywords:** revision support system, academic writing skill, revision skill, comments classification, laboratory education

## 論文審査の結果の要旨

本論文は、論文執筆等のアカデミックライティングにおいて従来支援が困難であった推敲活動に焦点を当て、研究室における過去の論文修正過程を、論文執筆時の他者からのコメントと原稿中の修正箇所からなる **Revision Corpus** として活用することで、学生の文章推敲スキルの向上を目的とした適応的な支援を実現するための手法を提案したものである。

文章執筆時の推敲支援に関する先行研究は様々なものが存在するが、文法や表現と比較して、文章の内容に基づく支援を、文章推敲スキルの獲得過程をモデル化して整理を

試みた研究は存在しておらず、その点で独創性の高い研究であるといえる。また、提案モデルに基づいた支援システムである TRONA (Topic-based RevisiON Assistant)を開発し、研究室内で蓄積された Revision Corpus を入力としたプロトタイプによる評価を可能とした。

具体的には、(1) 論文の推敲段階やコメントの重要度を評価することを目的として、項目群への応答に基づき対象の特性や項目の識別力を統計的に測定する手法である Item Response Theory を援用することで、教員の評価と相関の高い推定が行えることを示し、(2) Revision Corpus の中で内容の推敲に関するものとそうでないものを、コメント中のキーワードだけでなく、修正箇所との編集距離やコメント・修正箇所の長さなどの素性を組み合わせて機械学習することで一定の精度で分類を行った。これらの学生の推敲スキルレベルに応じた支援を実現するため要素技術に対する有効性は一定の水準にあるといえる。

提案手法の最終的なゴールである認知的スキルとしての推敲スキルの向上につながるかどうかについての長期的な検証には至っていないものの、研究室における論文執筆指導の一環としての推敲活動支援の観点からは必要な機能を備えたものとなっているといえる。

以上、本論文は、アカデミックライティングにおける文章推敲スキル向上のためのトレーニングモデルを提案し、統計的手法や機械学習等の情報科学的手法を教育工学的な課題に適用を試みたものであり、その成果は、データに基づく新たなスキル学習に対する支援像を示したという観点から学術的に貢献するところが大きい。よって、博士（情報科学）の学位論文として十分価値あるものと認めた。