

Automating Assessment of Collaborative Writing Quality In Multiple Stages: The Case of Wiki

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ABSTRACT

This study attempts to investigate to what extent indicators of academic writing and cognitive thinking can help measure the writing quality of group collaborative writings on Wikis. Particularly, comparisons were made on Wiki content in different stages of the projects. Preliminary results from a multiple linear regression analysis reveal that linguistic indicators such as engagement markers and self-mention were significant predictors in earlier stages to the projects, whereas verbs indicating cognitive thinking in the evaluation level were significant in later project stages.

CCS Concepts

• Human-centered computing→Wikis • Social and professional topics→Student assessment • Computing methodologies→Natural language processing • Applied computing→Collaborative learning

Keywords

wiki; automated assessment; metadiscourse.

1. INTRODUCTION

Wiki is a platform where users or visitors can create new pages, modify existing ones, and re-structure the hierarchy of pages, serving as a collaborative authoring environment for complementing and enhancing online collaboration **Error! Reference source not found.** The simplicity and flexibility of Wikis make it a predominant tool employed by instructors in this age of collaborative learning.

However, the use of Wikis might raise the complexity of the learning environment for the instructors, since they have to monitor quantity and quality of the shared written work. Automated evaluation of writing quality can hence be experimentally applied to scoring Wikis in terms of their contents. In view of the under-studied topic of automating the assessment of writing quality on collaborative Wikis, this study attempts to explore to what extent common linguistic features of academic writing and cognitive thinking can be used to predict the quality of students' online collaborative writing. In addition, as one of the major advantages of Wiki is to be able to record all historical versions of the pages, it provides an ideal case to study the

evolution of student collaborative writing. Therefore, in this study we examine Wiki pages at different stages of the collaborative writing projects. Specifically, this study aims to answer: to what extent can linguistic indicators of academic writing and cognitive thinking help measure the quality of collaborative writing in different stages?

2. LEARNING ANALYTICS IN ASSESSING COLLABORATIVE WRITING

Various existing studies have been conducted to design analytical tools to help teachers observe and monitor the progress and contributions of students on their group assignments, but most of them focused on the quantitative aspects such as revision counts and words added. The concern remains as to whether the quality of collaborative writing on Wiki is automatically assessable. Previous studies applied Natural Language Processing (NLP) techniques to automatically assessing free-text answers in examinations. Dowell *et al.* [3] analyzed the use of discourse features to predict group performance during collaborative learning interactions. However, they explored the content of group chats rather than the writing itself. In another LA-infused study, Kim *et al.* [6] analyzed the topic of each collaborative Wiki page, but did not assess the quality of writing. Another pertinent study [2] probed numerous quality indicators and looked into how capable these indicators were to assess the quality of Wikipedia articles. Coming close to the conceptual framework of the present study, their study paves the way for our study to evaluate to what extent textual features (i.e., quality indicators) of collaborative writing can help accurately and comprehensively assess Wikis created by university students for knowledge co-construction, instead of the Wikipedia articles created by the public.

3. METHODOLOGY

Wikis in three undergraduate courses at the University of Hong Kong were selected for the present study, namely two under the Bachelor of Science in Information Management programme (BSIM3004 Information Retrieval; BSIM4018 Data Warehousing and Data Mining) and another being a common core course (CCST9003 Everyday Computing and the Internet) that all undergraduate students could enroll in. Although the courses had different group collaborative tasks (e.g., compiling an annotated bibliography, writing a report on an innovative computing technology), we combined the Wikis in these courses together on the premise that all tasks involved collaborative academic writing. It is our intention to explore indicators that can be applied to various disciplines and tasks. Seventy-eight group Wikis were obtained from these courses, as well as their final marks given by the instructors.

To investigate student collaborative writings in different stages of group projects, for each Wiki we collected its snapshots at the first quarter of the project, second quarter and third quarter, in addition to its latest content. The project period was established as starting

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from the time of the first editing among Wikis of one course, and ending at the time of the last editing. This segmentation was intended to examine the changes in measures along the project process. We first extracted the pages from the Wikis, then HTML tags and redundant blanks were eliminated before a set of measures of quality indicators were calculated. In the meantime, the performance scores of the student groups given by the instructors were taken as the scores of human evaluation. The measurement output was then for further statistical analysis.

3.1 Quality indicators

By identifying and selecting linguistic features from multiple sources, this study attempts to explore the potential of these indicators in building a model for predicting human scores of Wiki writing quality.

Metadiscourse features: Metadiscourse refers to the linguistic and rhetorical manifestations in the text. Social constructionist researchers have been using metadiscourse as an orientation to analyzing discourse, while Wikis are regarded as an online environment that embodies social-constructivist principles through co-construction of knowledge [7]. In our view, this denotes that metadiscourse features serve as important markers in not only general academic text-styles but also in collaborative writing (i.e., Wiki). Specifically, these features include attitude markers, boosters, code glosses, endophoric markers, engagement markers, evidentials, frame markers (goal-announcing, sequencing, stage-labelling and topic-shifting) hedges, qualifiers, person markers (self-mentioning) and transition markers [5]. Our study treats these 14 linguistic features as the potential quality indicators of academic writing in the Wiki context.

Bloom's Taxonomy: Bloom's Taxonomy is a well-defined and broadly accepted tool for categorizing types of thinking into six different levels: knowledge, comprehension, application, analysis, synthesis, and evaluation, where this Taxonomy has been widely used in educational settings to measure students' ability [4]. In relation to Wikis, an objective of this collaborative writing practice is to prompt students' critical thinking. Knowledge building using Wikis has also been shown to have connections with students' cognitive processes [1]. The present study therefore treats the above six features as the possible quality indicators of cognitive thinking embodied in Wiki writing.

3.2 Statistical Analysis

For each of the datasets, a multiple linear regression analysis was conducted using the quality indicators as the independent variables and the scores as the dependent variable, in an attempt to build a model to predict scores of human evaluation.

4. RESULTS AND DISCUSSION

Table 1 below shows the quarter-based results of the linear regression analysis. Results from the first quarter are not shown due to the absence of significant values. "Evaluation" (in the Bloom's Taxonomy) was statistically highly significant ($p < 0.01$) in both the third quarter and in the full-data context, meaning that this feature possessed the explanatory power for the dependent variable of human score. "Evaluation" words (e.g. compare, describe, justify, etc.) would likely lead to a higher score, making this feature a relatively significant predictor of the scores of Wikis. Other moderately statistically significant ($0.01 < p < 0.05$) features included "Engagement markers" and "Self-mention" which were prominent in the second and third quarter, corresponding to the earlier stage of students' progress on the Wikis. It is noteworthy that "Self-mention" had a negative regression coefficient, meaning that this indicator contributed to the scores negatively.

Table 1. Quarter-based regression analysis for selected indices predicting Wiki scores

	2nd quarter	3rd quarter	Latest version
Features	Coefficients (Std. Error)	Coefficients (Std. Error)	Coefficients (Std. Error)
Application	-0.273 (15.616)	-0.244* (11.707)	-0.140 (11.834)
Comprehension	0.042 (39.824)	0.173 (25.428)	0.191* (30.580)
Engagement Markers	0.469* (13.113)	0.326** (11.476)	0.205 (12.219)
Evaluation	-0.265 (36.903)	0.367*** (31.282)	0.565*** (42.207)
Qualifiers	0.723** (23.020)	0.056 (17.523)	-0.100 (20.662)
Self-mention	-0.441** (43.778)	-0.319** (41.057)	-0.257 (42.540)
Topic-shift	-0.587* (17.500)	-0.158 (14.292)	-0.154 (13.714)
Transition Markers	0.498** (16.643)	0.040 (15.332)	0.085 (15.832)
R ²	0.561	0.507	0.525

Note: * indicates significance at $p < 0.10$; ** at $p < 0.05$; *** at $p < 0.01$.

5. CONCLUSION

This study aimed to explore the potential of indicators of academic writing and cognitive thinking in measuring the quality of Wiki collaborative writing in different stages of group projects. Results demonstrated that a few textual features, especially towards the final stage of the Wiki project, appeared to have the predictive power on the human scores. Future work is needed to explore other quality indicators and their generalizability across courses of different disciplines.

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