Rethinking Authorship in the Age of AI: Insights from Writing Analytics and Human-AI Collaboration

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The integration of large language models (LLMs) into academic settings introduces significant opportunities and challenges, particularly in evaluating the dynamics of human-AI collaboration through writing analytics.

Our study builds on recent research into the characteristics of essays written with and without generative AI support, using advanced writing analytics to explore how AI enhances or inhibits student writing skills. By examining stylometric features and employing deep learning techniques, our work aimed to understand AI's implications in academic writing and provide educators with tools to evaluate human-AI interactions and maintain academic integrity while supporting effective learning.

Three key research questions drove our investigation, all centred around understanding and evaluating human-AI interactions in writing. First, we explored the differences between student-written essays and those generated by AI, focusing on vocabulary diversity, sentence structure, and readability. Using Natural Language Processing (NLP) techniques, such as syntactic complexity and lexical density metrics, we found that AI-assisted essays exhibited higher lexical diversity and readability scores compared to student-only essays.

Second, we developed a stylometry-based authorship attribution model using a BERT transformer to distinguish between student and AI-generated text. By leveraging key linguistic features, the model demonstrated high accuracy (0.99), precision (1), and F1-scores (0.99) in identifying documents generated by AI, surpassing the adopted baseline. This model demonstrated a robust method for evaluating the extent of AI involvement in academic writing.

Third, we extended the authorship attribution model to quantify AI involvement at the sentence level within collaborative essays. The application of our authorship attribution algorithm from Study 2 was expanded to analyse blended human-AI collaborative essays. The goal was to quantify AI involvement in essay composition and assess its influence on writing processes. To simulate real-world human-AI collaboration, we expanded our student corpus using the OpenAI GPT-4 API, generating AI-assisted essays based on specific prompts designed to retain the original student writing style. By applying sequential labelling techniques, each sentence was then tagged as either student or AI-authored. Our results showed clear differences in vocabulary use, sentence structure, and punctuation patterns between human-AI-generated and student-written essays. For instance, human-AI-generated essays tended to use a higher frequency of rare and long words, and featured higher readability scores, indicating a more complex academic tone. Overall, our findings contribute to ongoing debates about the role of AI in academic writing and writing analytics by demonstrating that the linguistic and stylistic distinctions between human and AI writing can be robust enough to be detected through machine learning.

The implications of our current study for educational practice are significant. For students, these findings can lead to more personalised feedback on their writing. By comparing AI-generated and student-authored texts, educators can better understand the nuances of each student's writing style, enabling targeted feedback to improve specific aspects such as vocabulary use or syntactic complexity. For example, if a student's writing demonstrates lower-than-expected lexical diversity or readability scores compared to typical submissions, educators can recommend exercises or resources

to help expand their vocabulary and enhance their writing skills. This approach promotes self-regulated learning and encourages students to develop stronger independent writing abilities without over-relying on AI tools. Moreover, analysing extracted stylometric features from essays can significantly inform curriculum development. If a trend of low type-token ratios is observed across the majority of submissions, educators can implement strategies to enrich students' language use and expand their vocabulary. By incorporating targeted interventions based on these insights, educators can address specific student needs more effectively and provide enhanced support.

Finally, our research into human-AI collaboration within essays offers important insights into how students may integrate AI-generated content into their work. By quantifying the degree of AI involvement at the sentence level, we provide educators with a clearer understanding of how AI is being used in the writing process. This can inform academic policies on acceptable uses of AI in coursework. For example, if AI assistance is permitted in brainstorming but not final submissions, these models could help track and enforce such policies by identifying where AI-generated content is present. In turn, this enables institutions to set clear guidelines and educate students on the ethical and responsible use of AI.

In conclusion, this study advances our understanding of human-AI collaboration in academic writing by employing stylometric analysis and deep learning to evaluate human-AI interactions.