Text-matching Software in Post-secondary Contexts: A Systematic Review Protocol

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Abstract

This protocol outlines the methods for our systematic review on commercial text-matching software (TMS). We propose to use Joanna Briggs Institute's (JBI) Methodology for Mixed Methods Systematic Reviews. This systematic review will provide insights into how TMS is used in post-secondary contexts, highlighting evidence relating to how well such software reduces incidences of plagiarism, and also how it can be used for educational purposes to support student learning at the undergraduate and graduate levels.

Keywords: academic integrity, Canada, plagiarism, plagiarism detection, systematic review, text-matching software

Systematic reviews have become an established method in medicine and health sciences to inform policy and practice decisions (Torgerson, 2003). Even though educational researchers were among the first to use systematic reviews (Torgerson, 2003), their use in the field of education has remained limited when compared to their proliferation in health and medical sciences.

Writing and publishing a protocol is an established first step in the systematic review method (Newman & Gough, 2020; Torgerson, 2003). Systematic reviews differ from narrative literature reviews in that their methods are explicit and "open to scrutiny" (Torgerson, 2003, p. 6). Having the protocol itself peer-reviewed and published (as in this case) helps to establish the overall credibility of the systematic review (Torgerson, 2003).

The objectives of the protocol, as established in the methodological literature, are to establish: (a) the conceptual and empirical background for the review; (b) the research questions; (c) and the objectives and scope of the review, including the methods for

screening, searching, extracting data, and synthesizing the results (Torgerson, 2003). This protocol follows these objectives.

Background

Post-secondary learning is more complex than ever before; so too, are skills related to citing, referencing, information literacy, research, and writing. Plagiarism continues to be a major issue in post-secondary education (Edwards et al., 2019; Gasparyan et al., 2017). In recent decades, researchers and educators have called for a move away from punitive approaches to address plagiarism and other forms of academic misconduct (Bertram Gallant, 2008). A marked epistemological shift occurred in research and educational contexts when McCabe popularized the term "academic integrity," reframing the behavioural focus on academic misconduct to a values-based focus on integrity (McCabe, 1993, 2005; McCabe et al., 2001; McCabe & Pavela, 2004). This shift in thinking corresponded with an intensification of research about breaches of academic integrity, although the field remains under-developed in comparison with other areas of educational research (Eaton & Edino, 2018; Macfarlane et al., 2014).

A particular topic of debate among academic integrity researchers has included the impact of the Internet on plagiarism. Some scholars assert there has been a cause-and-effect relationship between the development of digital technologies and an increase in copy-and-paste practices, leading to more plagiarism (Batane, 2010; Ison, 2015; McMurtry, 2001; Oliphant, 2002; Stephens et al., 2007). Others argue that plagiarism has existed for centuries and there is little empirical evidence to support the idea that the Internet itself is responsible for increases in academic misconduct (Moore Howard & Davies, 2009; Panning Davies & Moore Howard, 2016). Regardless of whether a causal link can be empirically proven, ample evidence exists to suggest a correlation between evolutions in technology and the ease of copying and pasting text digitally from one source to another (Baruchson-Arbib & Yaari, 2004; Edwards et al., 2019; Sayed & Lento, 2015). The emergence of the copy-and-paste culture, which has propagated an online sharing culture, has also resulted in more unintentional plagiarism, as the gap widens between socially acceptable sharing practices among friends and customary source attribution practices in post-secondary contexts (Blum, 2009, 2016).

The emergence of text-matching software (TMS) (also called "plagiarism detection", "anti-plagiarism", or "plagiarism prevention" software) has coincided with advances in learning technologies, contributing to scholarly debates in the field. Some have suggested such software provides an easy and effective means to detect and deter plagiarism (Batane, 2010; Braumoeller & Gaines, 2001; Culwin & Lancaster, 2001; Strawczynski, 2004). Others have pointed out the potential for TMS to be used as a formative assessment tool to provide

students with feedback about how to improve their writing and offer opportunities for academic integrity education (Bischoff & Ábrego, 2011; Buckley & Cowap, 2013; Edwards et al., 2019; Halgamuge, 2017; Kloda & Nicholson, 2005; Zaza & McKenzie, 2018). However, such software is not without limitations. TMS can be costly and the results can be misleading, including false postives and false negatives (Weber-Wulff, 2016). In addition, there has been robust debate about the complexities of TMS, including moral and legal implications, particularly with regards to intellectual property and copyright, privacy concerns, and the erroneous assumption that such software relieves educators entirely from the complicated task of detecting plagiarism themselves (Foster, 2002; Moore Howard, 2013; Strawczynski, 2004; Stommel, 2015; Zaza & McKenzie, 2018).

Text-matching software can be classified in a number of different ways. One classification includes open source or open architecture software (Butakov & Shcherbinin, 2009; Culwin & Lancaster, 2001). These are often developed by research groups or partnerships, usually specializing in computer science, with an interest in sharing openly accessible tools with fellow scholars and educators.

More recent innovations include the Trust-Based Authentication & Authorship e-Assessment Analysis (TeSLA) tool, an EU-funded initiative developed by a consortium of 18 partners (Baró-Solé et al., 2018; Edwards et al., 2019). The TeSLA tool was designed to improve e-assessment, with specific capabilities relating to authentication and authorship confirmation. While the TeSLA innovation may have the potential to be a disruptive technology for academic integrity, as yet it is immature when compared to more established tools (Edwards et al., 2019).

Another category includes the large-scale commercially available products, which can sometimes be integrated with institutional learning management systems (LMS). Such products include, but are not limited to, Turnitin, iThenticate, Copyscape, CopyCatch, SafeAssign, and Urkund (Culwin & Lancaster, 2001; Edwards et al., 2019). It is this final category that we have chosen to focus on. Despite the increased use of commercially available TMS, there seems to be little evidence-based guidance available for institutions, administrators, or individual educators considering its adoption about how to make evidence-informed decisions about the potential value and limitations of the available tools.

Previous systematic reviews

In this section we present a brief overview of other recent systematic reviews in the field, explaining how ours differs from them.

Recently, Foltýnek et al. (2019) published a systematic literature review focusing on academic plagiarism detection. Their review sought to critically appraise "the capabilities of computational methods to detect plagiarism in academic documents" and to identify "current research trends and research gaps" (p. 111). This study is noteworthy as it provides a comprehensive overview of the mechanics of and computational possibilities for academic plagiarism detection. The authors determined that there are different computational detection methods for different forms of plagiarism.

Our proposed systematic review does not focus on the *how* of detecting plagiarism; rather, we are approaching our review from a teaching and learning framework, and are interested in uncovering ways in which TMS is used in post-secondary contexts to reduce incidences of plagiarism and its effectiveness as an educational intervention. We will not be reviewing the literature for examples of computational methods such as machine learning. Rather, we want to explore educational interventions that use TMS to teach students about their academic integrity responsibilities. The Foltýnek et al. (2019) review "excluded papers addressing policy and educational issues related to plagiarism detection to sharpen the focus of our review on computational detection methods" (p. 112). Our systematic review will address the educational issues, with an aim to inform policy.

Other recent reviews (Awasthi, 2019; Macfarlane et al., 2014) have investigated academic integrity. Macfarlane et al. (2014) discuss the academic integrity research within three themes: teaching, research, and service. The researchers determined that a wide range of research methodologies are utilized to study academic integrity, including both quantitative and qualitative methods. Questionnaires/surveys and documentary analysis were the most common research approaches. As these researchers conducted a literature review, rather than a systematic review, they did not critically appraise each included study. Further, their review encompassed all aspects of academic integrity, and did not specifically address the use of TMS as an educational intervention for academic integrity. Our proposed systematic review addresses this gap.

Awasthi (2019) stated that she conducted a systematic review and included anti-plagiarism software in her analysis. However, the search was very limited and did not include all possible variations of keywords. Specifically, she only searched the keywords "academic misconduct" and "plagiarism". Further, only one database, Scopus, was searched. Therefore, we expect that her review missed relevant studies. As well, the researcher noted that 408 articles were "considered relevant for the study" (p. 95). However, only a small number of studies are discussed in the review; the reference list only has 52 citations, not 408 as indicated by the number of relevant studies. As well, the author did not critically appraise the studies included in her review. Our proposed systematic review will be comprehensive by searching 15 different databases with an exhaustive search, designed by

an expert librarian, that incorporates a wide range of relevant keywords and subject headings. We will also critically appraise the literature.

Rationale

Knowledge synthesis is an umbrella term for a variety of review styles and approaches specifically focused on the systematic collection, summary, assessment, and synthesis of all available evidence on a specific research topic. Knowledge synthesis approaches are quite distinct from literature reviews in that the review styles subsumed under the heading of knowledge synthesis are a unique set of research methodologies where the evidence under investigation is composed of an analysis of ongoing work on the topic of interest. In other words, the data being collected for analysis consists of published studies and conference proceedings, as well as various forms of documentation and grey literature. The most comprehensive manifestation of the knowledge synthesis methodology is the systematic review because, as the name suggests, a systematic review aims at a robustly structured, systematic, and transparent approach to data collection, evaluation, and synthesis. A salient part of the long and deliberate process that ensures transparency, replicability, and accountability is the creation of a protocol, which not only serves as a guide for the researchers, as a regular research proposal would, but is also peer reviewed and often published. "The review protocol sets out the methods to be used in the review. Decisions about the review question, inclusion criteria, search strategy, study selection, data extraction, quality assessment, data synthesis and plans for dissemination" are included (University of York, 2009, p. 6). This feature distinguishes a protocol from a normal proposal; the purpose of publishing a protocol is both to promulgate the research being initiated as widely as possible, to ensure transparency, and avoid bias. "For similar reasons as have been proposed for randomized trials, systematic reviews should be registered and have published protocols" (McKenzie et al., 2016, p. 635) since "[a]n open registry of reviews captured at the protocol stage would facilitate good practice in systematic reviews by providing transparency of the review process and outcomes" (Booth et al., 2011, p. 108). Thus, the publication of the protocol is an integral component of the provision of transparency and future replicability of the proposed review.

The purpose of this systematic review is to understand how commercially available TMS is used in post-secondary contexts.

Objectives

Research Questions

The specific question we will address is: How is text-matching software used in post-secondary contexts?

- Sub-RQ1: What is the effectiveness of such software in reducing incidences of plagiarism?
- Sub-RQ2: What is the effectiveness of such software as an educational intervention?

Methods

A number of terms mentioned in this protocol are explained in the glossary at the end of the article.

Design

Our review will be guided by the Joanna Briggs Institute's (2014a) (JBI) Methodology for Mixed Methods Systematic Reviews. This framework integrates both quantitative and qualitative research into a single systematic review. We recognize that both the published literature and grey literature in the area of TMS will include different research methods as well as theoretical and expert opinion papers. Pluye and Hong (2014) suggest "the main rationale for conducting a mixed studies review is to better understand complex interventions, programs, and phenomena" (p. 36). Further, research focused on TMS is still emerging, and different study perspectives need to be captured in our review. Therefore, "by including diverse forms of evidence from different types of research, mixed methods reviews attempt to maximize findings – and the ability of those findings to inform policy and practice" (JBI, 2014a, p. 5).

JBI's framework for mixed method reviews suggests that synthesis of data from qualitative and quantitative studies be conducted separately in a "segregated approach" (JBI, 2014a, p. 19) and then aggregated. However, we will take an adapted approach, as we do not expect the quantitative data to support a meta-analysis. Study selection will be conducted simultaneously for all study designs. We will then separately appraise the evidence from qualitative, quantitative, and textual/theoretical studies using appropriate critical appraisal tools for each study design. Data synthesis will be guided by Popay et al.'s (2006) narrative approach. We ultimately aim to provide a holistic and comprehensive analysis of the use of TMS in the post-secondary environment. Our systematic review protocol was developed in light of the PRISMA-Protocols checklist (Shamseer et al., 2015).

Eligibility Criteria

Through this review, we seek to understand the use of text-matching software in post-secondary contexts. We will use the PICo mnemonic to frame our research question and inclusion/exclusion criteria. This mnemonic "identifies the key aspects ***P***opulation, the phenomena of ***I***nterest, and the ***Co***ntext" (JBI, 2014b, p. 12, emphasis added).

Population

The population under study are undergraduate and graduate students. This is because the research team is concerned with matters relating to academic integrity in post-secondary contexts. We made a decision to limit the scope of our work to this population.

Phenomenon of Interest

Studies will be included if they explore commercially available TMS. For the purpose of our review, we situate TMS as an intervention used to help students avoid plagiarism and learn how to write more effectively and help faculty identify possible instances of plagiarism in student work and provide formative feedback to students. We will also include studies that investigate TMS from a legal or theoretical perspective when situated within a student context. Studies that investigate the use of TMS for identifying or reducing plagiarism amongst faculty/instructors/other academics will not be included in our review; specifically, the intervention, TMS, must be focused on students to be included. Further, proprietary, open access software, or text-matching programs that are not commercially available will be excluded.

Context

Studies will be included in our review if they involve stakeholder groups in a post-secondary context. We adopted the definition of "post-secondary" as being inclusive of "universities, community college, trade and vocational training centres" (Statistics Canada, 2018). Post-secondary stakeholder groups include faculty, students (both undergraduate and graduate), instructors, researchers, student support staff, librarians, and others who are directly involved in supporting or guiding student success and academic work.

Outcomes

The PICo framework does not always identify outcomes. This review will investigate all outcomes from the included literature. We expect two possible outcomes will be present, but anticipate other outcomes will be identified.

1. Reduction in the number of instances of plagiarism found in students' academic work as a result of using TMS.

2. Increased awareness and understanding among students and faculty about what plagiarism is and how to avoid it, as well as how to improve academic writing skills.

Study Design

The review will include all study designs and types: qualitative, quantitative, mixed methods, and theoretical or opinion. There will be no restrictions on language, date of publication, or geographic location. We will not include popular media, blogs or social media postings, how-to articles, product information or advertising, and text-matching software used in the production of a source (i.e., if a manuscript was run through the software). Conference presentations will only be included if a full-text version is available (i.e., not just an abstract).

Information Sources

As our review is focused on discovering and exploring the use of commercially available TMS in post-secondary contexts, both subject specific and interdisciplinary databases will be searched in order to ensure that the search is comprehensive (Table 1). Grey literature will also be searched (Table 1).

Table 1. ***Information Sources***

Published Literature	
Subject Specific Databases	***Interdisciplinary Databases***
ABI / Business Premium Collection (Business)	Academic Search Complete
Business Source Complete (Business)	International Bibliography of the Social Sciences (IBSS)
CINAHL Plus with Full Text (Nursing)	Scopus
CiteSeerX (Computing Science)	Web of Science

Compendex (Engineering)	
Education Research Complete (Education)	
ERIC (Education)	
Library and Information Science Abstracts (Library Science)	
Library & Information Science Source (Library Science)	
MEDLINE (Medicine and Health Care)	
PsycInfo (Psychology)	

Grey Literature

Conferences	***Other Sources***
Asia Pacific Forum on Educational Integrity (APFEI)	ProQuest Dissertations & Theses Global
International Center for Academic Integrity (ICAI)	Ethos e-theses online service (UK)
International Society for the Scholarship of Teaching and Learning (ISSOTL)	Open-Grey
Plagiarism Across Europe and Beyond	OAIster

Search Strategy

A preliminary scan indicated that the majority of the literature is situated within post-secondary contexts. Therefore, in order to maximize results, the search strategy will include only the Phenomenon of Interest: "text-matching software". The search will be developed in ERIC, an educational database, and then adapted for other databases. Both keywords and subject headings will be used for the concept. Keywords will be constant across databases and subject headings will be responsive to the controlled vocabulary of each database. Table 2 outlines the proposed search strategy, developed by two librarians

(KAH, BL). Snowball searching will also be used to ensure exhaustiveness of the data collection. Specifically, reference lists and "cited bys" of included studies will be searched.

Table 2. ***Provisional Search Strategy (ERIC)***

#	Query	Results
S16	S8 OR S15	495
S15	S9 OR S10 OR S11 OR S12 OR S13 OR S14	366
S14	(Turnitin* or iThenticate or SafeAssign or CrossCheck or Copyscape or CopyCatch or Urkund)	83
S13	"text match*" N5 (software or tool* or program* or computer* or online or internet or product*)	11
S12	antiplagiarism N3 (software or tool* or program* or computer* or online or internet or product*)	8
S11	anti-plagiarism N3 (software or tool* or program* or computer* or online or internet or product*)	13
S10	(plagiarism or cheating) N3 (software or tool* or program* or computer* or online or internet or product*)	226
S9	(plagiarism or cheating) N3 detect*	187
S8	S4 AND S7	268
S7	S5 OR S6	2,362
S6	SU "Cheating"	1,630
S5	SU "Plagiarism"	1,178
S4	S1 OR S2 OR S3	54,461
S3	SU "Information Technology"	16,927
S2	SU "Computer Uses in Education"	22,890

S1	SU "Computer Software"	21,757

Data Management

All search results will be exported to Covidence, a web-based platform for systematic reviews. Covidence deduplicates search results and facilitates screening (i.e., study selection).

Study Selection

Study selection will be conducted by content experts in two phases. The first phase involves screening records by titles and abstracts in Covidence. Prior to commencing the screening, the content experts will pilot screen 50 records to be sure that they are consistently applying the inclusion/exclusion criteria. If required, the inclusion/exclusion criteria will be further defined and described. After pilot screening, two content experts (KC, SEE) will independently screen the titles and abstracts of all retrieved records. Results will be compared, and disagreements resolved through consensus and, if necessary, a third content expert (LAP). Studies identified as meeting the inclusion criteria, as well as those that are potentially relevant or for which more information is required, will be included in a second phase of screening.

The second phase of screening involves reviewing the full text of each study, again applying the inclusion and exclusion criteria. Two content experts (SEE, KC) will independently screen the full texts. Disagreements will be resolved through consensus and a third reviewer (LAP).

The PRISMA Flow Diagram (Moher et al., 2009) will be used to report study selection from all search results to the final records included in the synthesis.

Data Extraction

JBI guidance (JBI, 2014a) suggests utilizing different extraction details for different types of studies (quantitative, qualitative, text/opinion) that are integrated into the JBI SUMARI online resource. However, in order to simplify the data extraction process, as our review is not using SUMARI, one standardized data extraction template will be developed in Excel to integrate the components from different study types.

The template will be piloted on five purposively selected included studies (i.e., qualitative study, quantitative study, mixed methods study, theoretical) to be sure that all categories for data extraction have been identified. The content experts (SEE, LAP, KC) will first meet and jointly work through extracting the data for five studies to be sure that everyone understands the data extraction template. The data extraction template will be revised as required to best meet the data elements for each type of study. The remaining studies will then have data extracted independently by the two content experts (KC, SEE). Disagreements will be resolved through consensus or discussion with a third content expert (LAP). Table 3 presents the provisional data extraction components.

Table 3. Provisional Data Extraction Components

Component	Description (Data to be Extracted)
Study Citation Information	Author, Year of Publication, Endnote #, Title of Article, Type of Publication, Language
Design / Characteristics	Aim, study design/study type, recruitment, sample size
Setting	Country/geographical location (note institution), other setting details provided in study
Participants	Age, gender, program, year of study
Intervention	Description of the intervention, how it was developed, used, implemented and evaluated
Data Collection	Details on how data was collected; variables measured, who conducted data collection; attrition rate; instrument used (reliability and validity of instrument)
Argument	Theoretical / opinion studies
Outcomes	All outcomes identified
Conclusions	Author(s) conclusions / impact
Limitations	Limitations noted by authors; other limitations identified by SR team
Bias	Selection, performance, detection, attrition, reporting

Quality Assessment

Due to the various typologies of the literature under review, there is no one single tool ideal for appraising all types of articles. For this reason, two critical appraisal tools, the Mixed Methods Assessment Tool (MMAT) (Hong et al., 2018) and the JBI Checklist for Text and Opinion (JBI, 2017) have been selected. To better understand and pilot these tools, a critical appraisal of four articles on text-matching was undertaken using these two tools. Three content experts from this team (KC, LAP, SEE) reviewed papers, with two reviewers appraising each of the four articles. They independently selected the most appropriate tool for the text and then followed the protocols outlined in each tool. They then all came together to discuss results. Through this trialling and discussion, they agreed on the suitability of the two appraisal tools for this systematic review.

The MMAT is useful for appraising the majority of texts and can be used with qualitative, quantitative, and mixed-method studies. It is designed to assess the quality of five categories of studies: qualitative research, randomized control trials, non-randomized control trials, non-randomized studies, quantitative descriptive studies, and mixed methods studies (Hong et al., 2018, p. 1). This tool is ideal for assessing the quality of empirical studies; however, it is also effective for appraising non-empirical research such as theoretical or review papers.

There are two parts of the MMAT: the checklist and the criteria. The tool also provides instructions on its use and screening tests to determine whether it is the most appropriate tool for a particular paper.

Data Synthesis

Our systematic review will first present the extracted data and quality assessment in tabular form to summarize each included study. As previously noted, we do not expect to be able to conduct a meta-analysis for the quantitative studies. Therefore, a narrative synthesis for all types of studies, guided by Popay et al. (2006), will be undertaken. Popay et al. (2006) define narrative synthesis as "an approach to the systematic review and synthesis of findings from multiple studies that relies primarily on the use of words and text to summarise and explain the findings of the synthesis" (p. 5). The researchers outline four elements for the narrative synthesis process:

- developing a theory of how, why, and for whom the intervention works,
- developing a preliminary synthesis of findings of included studies,

- exploring relationships in the data, and
- assessing the robustness of the synthesis (p. 11).

Until data synthesis is completed, it is unknown if we will be able to develop a theory as to how TMS works as an intervention. However, the three remaining elements will be conducted during the narrative synthesis.

Discussion

The aim of our mixed method systematic review is to understand how commercially available TMS is used in post-secondary contexts. To the best of our knowledge, no other truly systematic review has investigated TMS. We anticipate that the findings from our review will inform both practice and policy within post-secondary environments for the implementation and use of text-matching programs. In addition, our review may inform the design and development of further studies focused on TMS.

Glossary of Terms

Data Management Strategy: a plan for the creation, storage, and management of data.

JBI Methodology: the Joanna Briggs Institute is one of the several established organizations that offer robust frameworks for conducting review studies such as systematic reviews. JBI Methodology utilizes evidence-based methods for conducting replicable and transparent review studies.

PICO: a mnemonic device for the formulation of research questions (P stands for Patient or Problem; I stands for Intervention; C stands for Comparison; O stands for Outcome).

PRISMA: a checklist of items to be reported in a systematic review.

Search Strategy: a carefully formulated plan for finding information; a search strategy usually involves the development of search terms, synonyms that express the main concepts of the research question, and a list of databases and sources where the search will be implemented.

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