

Artificial Intelligence in Higher Education

A Practical Approach

Edited by

Prathamesh Padmakar Churi

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Artificial Intelligence in Higher Education

The global adoption of technology in education is transforming the way we teach and learn. Artificial Intelligence is one of the disruptive techniques to customise the experience of different learning groups, teachers, and tutors. This book offers knowledge in intelligent teaching/learning systems, and advances in e-learning and assessment systems.

Features include:

- Highlights the broad field of AI applications in education, regarding any type of Artificial Intelligence that is correlated with education.
- Discusses learning methodologies, intelligent tutoring systems, intelligent student guidance and assessments, intelligent educational chatbots, and artificial tutors.
- Presents the practicality and applicability implications of AI in education.
- Includes new and current research from research centers and higher education universities.
- Offers case studies of AI techniques in educational activities.

Artificial Intelligence in Higher Education: A Practical Approach will find interest with academicians which includes teachers, students of various disciplines, higher education policymakers who believe in transforming the education industry, research scholars who are pursuing their PhD or Post Doctorate in the field of Education Technology, Education, and Learning, and so on, and those working in the areas of Education Technology and Artificial Intelligence such as industry professionals in education management and e-learning companies.



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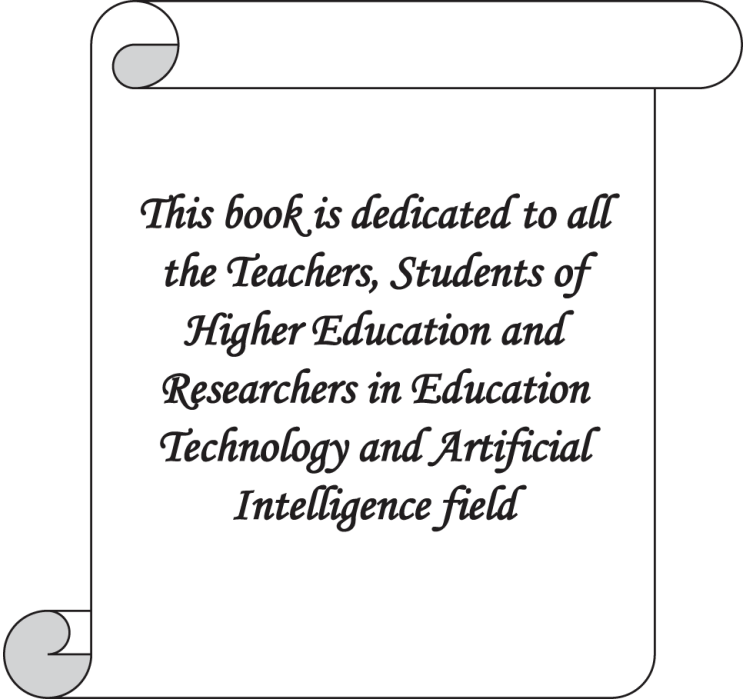
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*This book is dedicated to all
the Teachers, Students of
Higher Education and
Researchers in Education
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Preface

We are pleased to present to you our first edition of this book, *Artificial Intelligence in Higher Education: A Practical Approach*. The application of Artificial Intelligence has rapidly increased in many sectors including healthcare, e-commerce, banking, and supply chain management. The development of Artificial Intelligence-based educational techniques has been upgraded significantly over the past few years. Implementing Artificial Intelligence and artificial neural networks in education includes many kinds of intelligent instructional and evaluation techniques such as intelligent tutoring systems, intelligent assessment of student performance, intelligent virtual agents, talking robots, humanized chatbots, and any other educational technique based on Artificial Intelligence. Global adoption of technology in education is transforming the way we teach and learn. Artificial Intelligence is one of the disruptive techniques to customize the experience of different learning groups, teachers, and tutors. This book will provide knowledge regarding intelligent teaching-learning systems as well as advances in e-learning systems and assessment systems.

In the 1970s AIED (Artificial Intelligence Education) emerged as a specialist area covering new technology in teaching and learning, mainly in higher education. AIED aimed to provide more personalized, flexible, inclusive, and engaging learning, also automate daily learning tasks through automated assessment and feedback. In theory, AIED could help parents improve early linguistic development for their children, also help teachers choose tools, organize classes, increase participation, and personalize teaching for their students. AIED is contained as a robot or virtual assistance (Vas), and it combined virtual reality. It served as sensors that captured visual, auditory, and physiological data of students and teachers. This data type of learning can further understanding of how learning occurs in real time, and help teachers choose powerful approaches to teaching. AIED was purported to be capable of developing tools that help combat student or teacher burnout, and that may help eliminate the gap in achievement between students due to individual or social differences. However, despite decades of research, the tools developed thus far by AIED have not made full use of potential technology and seem far from fulfilling these promises.

This book is intended to enlighten the thrust of novel technological interventions in education and learning outcomes to foster pedagogies through Artificial Intelligence-based techniques to improve education needs that schematize better perspectives at large. The primary aim of this edited book is to help researchers, academicians, and educators develop principles for the design of computer-based learning systems. Its premise is that such principles involve the modeling and representation of relevant aspects of knowledge, before implementation or during execution, and hence require the application of AI techniques and concepts.

This book aims to highlight the broad field of Artificial Intelligence applications in education, regarding any type of Artificial Intelligence that is correlated with education, such as learning methodologies, intelligent tutoring systems, intelligent student guidance and assessments, intelligent educational chatbots, artificial tutors,

and so on, in order to advance and enrich the existing literature with new Artificial Intelligence approaches and methodologies in education.

The book contains 12 chapters written by 32 contributors from nine different countries which include India, Pakistan, Malaysia, Saudi Arabia, Russia, Spain, Swaziland, South Africa, and Malta. We are sure that this book will encourage researchers in this field.



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9 Artificial Intelligence-Based Tools in Research Writing

Current Trends and Future Potentials

Donnie Adams and Kee-Man Chuah

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9.1 INTRODUCTION

Research writing or academic writing has become a major component of learning and teaching across many disciplines in higher education (Strobl et al., 2019). The most common purpose of academic writing is to describe ideas or research findings and to convince the ‘audience’, which means the people reading the paper, such as instructors, professors and colleagues in the field, that the explanation is accurate. Research writing is strongly influenced by epistemological and communicative styles of the discipline (Poe et al., 2010) and genres used for teaching (Hyland, 2007; Nesi & Gardner, 2012), which result in a great range of procedures and skills involved in writing. These academic writing procedures and skills has become particularly challenging for both non-native English speakers and international students (Campbell, 2019). The use of English as the medium of instruction in many university graduate programmes has caused students difficulties with grammar, lexis and syntax (Singh, 2019). These difficulties worsen when students are faced with the

challenge of organizing ideas, sustaining arguments, defending claims and synthesizing ideas for their research writing (Belcher, 1994). Regrettably, very little is being done to prepare and equip graduate students in academic writing.

Research writing is a complex, indispensable, and integrative task that has a major influence on students' academic success (Rahimi & Zhang, 2018). Postgraduate students must fulfill various academic literacy demands such as individual project work, group projects, discussion group works and research dissertations or theses as part of their master's or PhD programme. In some cases, these students need to write and publish in citation indexed journals (CIJs) as part of their requirements to graduate (Adams et al., 2021). The greatest challenge among these tasks is producing written works free of language errors. These errors often create a negative first impression (Singh, 2019). Brown (2008), suggesting that students do not only face challenges in terms of vocabulary and grammar, but that they also have an inadequate understanding of academic writing standards and expectations from their lecturers. Approaches to improve writing proficiency have been widely discussed and assessed in the past (Graham & Perin, 2007; Strobl et al., 2019). Among the most effective measures for novice writers are extended practice, individualized feedback and strategy instruction (Allen et al., 2016). These measures, however, require considerable amounts of time, efforts and costs.

Questions begin to arise around to what extent research writing and training can be supported electronically (Crossley & McNamara, 2016). The emergence of Artificial Intelligence (AI) technologies have triggered a tremendous interest among educational technologists. One area that has received much attention is AI-based tools, developed to assist researchers in the writing process. AI-powered writing tools aim to not only ease the process of research writing but also to enhance the quality of critical analysis particularly in the aspect of literature review and language style. Despite the trends in adopting AI components within research writing, there are still-limited efforts to examine its implementation, strengths and weaknesses. This chapter reviews some of the key studies concerning AI in research writing as well as an extensive review of existing tools by covering their AI-based features, affordances and constraints. The chapter also includes a discussion on the future potentials of AI implementation with regard to research writing. This chapter would serve as a good reference to uncover the hidden potentials of AI-based tools in assisting students to produce high-quality research writing.

9.2 CURRENT TRENDS OF AI COMPONENTS IN RESEARCH WRITING

This section looks at trends of AI components by sketching their effect on research writing. The term 'tool' in this chapter refers to writing technologies ranging from programs, applications and platforms (Cotos, 2015). Artificial Intelligence (AI) on the other hand refers to an automated device with human intelligence processes such as learning, interpreting and self-correction (Popenici & Kerr, 2017). AI is able to analyze and do tasks as a human does (Strobl et al., 2019). As monitoring students' writing and providing timely, valuable and productive feedback is becoming too time-consuming and requires high levels of labor work, writing technologies are being developed to facilitate these needs (Lim & Phua, 2019). Computer-based

applications are increasingly being used as alternatives to facilitate research writing such as automated essay scoring (AES), automated written corrective feedback (AWCF) and automated writing evaluation (AWE) (Allen et al., 2016). These AI-powered writing tools can assist students to learn and develop their research writing skills.

New writing applications offer time-saving additions and flexibility to the writing curriculum (Koltovskaia, 2020). For example, AES has proven to reduce educators' grading workload. AWE is capable of providing both formative and summative feedback to students (Foltz et al., 2013). AWCF is an effective tool to improve student research writing engagement (Nazari et al., 2021). Thus, AI-powered writing tools now play an increasingly valuable role in research writing (Zhang, 2020). Apart from providing information about learning, AI applications can provide a thorough instructional practice and assist students in their research writing progress (Zawacki-Richter et al., 2019). Perhaps the most salient contribution of AI-powered writing tools are seen in assessment, feedback, tutoring and content generation for teachers and students (Nazari et al., 2021).

The literature shows that the AI-powered writing tools that have been used to automatically analyze research writing can be largely classified into four components, namely rule-based, corpus-based detection, natural language processing (NLP) and deep learning, or neural network. The rule-based tool is a grammar checking system commonly used to suggest and check common sentence structures and academic words in research articles. It provides detailed explanation of flagged errors thus making it an extremely helpful computer aided language learning approach (Soni & Thakur, 2018). Corpus-based tools use text summarization to identify important sentences from a substantial amount of information and produce a concise and fluent summary while preserving key information and overall meaning (Extance, 2018). NLP is the ability of a computer programme to detect the sentiment or tone in writing. The programme takes real-world input, processes it and attempts to understand human language (referred to as natural language) as it is spoken and written (Panesar, 2020). Deep learning, or neural network, programmes are capable of reading scientific papers and rendering a summary in a sentence or two. It is useful for helping writers get a preliminary sense of what these scientific papers are about and enables better decision-making in their research writing (Dangovski et al., 2019). Table 9.1 indicates the key areas where AI components are incorporated in the scope of research writing.

The remaining sections of this chapter will present an extensive review of AI in research writing as well as its features, affordances and constraints.

9.3 REVIEW OF STUDIES ON AI IN RESEARCH WRITING

Studies pertaining to the adoption of Artificial Intelligence in research writing are centred on the goal of not only increasing the efficiency in writing research materials but also providing useful information for researchers to make informed decisions. AI-based tools for specific purposes are rooted in the development of intelligent tutoring systems since the late 1980s (Richardson, 1988). The foundation of intelligent tutoring systems is the use of multiple independent modules to carry out a given

TABLE 9.1
The Key Areas Where AI Components are Incorporated in the Scope of Research Writing.

AI Approaches	Scope	Usages
Rule-based	Identification or detection based on specific linguistics rules (grammar)	<ul style="list-style-type: none"> • Grammar checker • Spelling error detection • Suggested word lists
Corpus-based	Summarization of corpus in creating patterns of usage and identifying collocations.	<ul style="list-style-type: none"> • Texts summarizer • Word concordance • Academic phrasebank
Natural Language Processing	The processing of human language for more complex linguistic analysis.	<ul style="list-style-type: none"> • Sentiment analysis • Tone/Diction analysis
Deep learning	Deeper analysis through neural networks or advanced AI with unsupervised training.	<ul style="list-style-type: none"> • Textual analytics • Advanced summarizer • Real-time intelligent tutors

function. For example, an expert module is used to store domain knowledge and captures underlying intelligence behaviour, while cognitive expert modules are created to simulate the actual human problem-solving capability within a domain or subject matter (Anderson, 1988, 1993). Essentially, AI-based tools are inspired by the idea of enhancing the learning of good writing through various affordances that are included within each tool, without replacing the role of the writer in the process (Crompton & Song, 2021; Khan et al., 2020; Lu, 2019).

In recent years, AI-based tools for research writing are geared towards facilitating the process of conducting common research tasks (such as literature review and data visualization) as well as providing continuous feedback to authors in improving their writing and proof checking (such as similarity index and spelling checkers). In a randomized controlled trial on 120 postgraduate students, Nazari et al. (2021) found that AI-based writing tools were able to improve the students' learning behaviour and attitudinal technology acceptance. The group with a specific focus on the tools were shown to produce better writing, as they are constantly given formative feedback. While the tools may at times offer inaccurate suggestions, they were largely useful in motivating the learners to be more confident in their research writing. Cotos et al. (2020) focused on the similar scope by developing the Research Writing Tool (RWT) that is capable of examining research writing through different forms of automated feedback. Grounded by the corpus-based approach, each written work is checked, and authors would be given both macro-level (structure, cohesion, etc.) and micro-level comments (sentence structures, word choice, etc.) for them to consider. The suggestions given by RWT offer great help for novice writers who may not be aware of a specific style of research writing within a discipline.

In relation to the feedback provided by AI-powered tools, some studies have shown how beginning writers are favouring automated feedback as compared to feedback provided by humans. Wang (2020) found such pattern in his study on 188

university students in China taking an advanced English reading and writing course, which was predominantly about writing scientific papers. The experiment revealed that the students preferred the feedback given through automated essay evaluation systems. The perceived effectiveness of the system was also higher than the teacher ratings. The three selected systems (Pigai, iWrite, and Awrite) were based on natural language processing in which a large corpus was used for the system to learn and identify the patterns of good writing. Through the systems' algorithmic matching and cross-examination, detailed individualized feedback is given to the students along with holistic scoring. Interestingly, Wang (2020) also discovered that because of the individualized feedback, students' independent learning ability and writing ability were vastly improved. This finding shows that AI-based tools are not merely to save time or make the process more convenient, but at the same time they are helping novice writers to learn the proper way of writing.

Moreover, the use of AI in research writing tools helps deal with some humanistic factors in writing, such as motivation and anxiety. It is widely known that most students or novice researchers lack the motivation to write scientifically due to the prevalent perception of the difficulty in producing research writing (Tansomboon et al., 2017). The AI-based tools are capable of offering unbiased feedback and responses for students to revise their written work. Tansomboon et al. (2017) explained how NLP tools can be capitalized to analyze student writing and select the most optimal guidance for each area of concern. Strobl et al. (2019) also highlighted how Automated Writing Evaluation (AWE) and Automated Essay Scoring (AES) systems are improving students' writing proficiency while increasing opportunities for formative feedback, rather than summative. Hence, students who get real-time support in the writing process (especially in scientific writing) are more likely to stay motivated and reduce their anxiety in writing.

The development of AI in research writing is not restricted to end-user tools alone. There are also studies that examine different ways to improve the AI processes from the rule-based engine to the more intelligent natural language processing. One example is the work by Sirbu et al. (2018) that specifically applied the ReaderBench framework to assess over 15,000 essays in order to generate 1,200 textual complexity indices. These indices were then grouped into four categories: word complexity, local cohesion, global cohesion and normalized word counts related to sentiment polarity (positive and negative). By creating these indices, an extensible rule-based engine could be developed in order to provide personalized feedback to users. Shum et al. (2016) also initiated the same efforts in going beyond the typical information retrieval metrics by introducing NLP-based writing analytics. The analytical tool harnesses the power of NLP approaches to examine various aspects of texts, from sentence difficulty to the cohesion of a writing. Additionally, Ullman (2019) examined the use of both machine learning and rule-based approaches in analyzing reflective writing. The machine learning model used in his study managed to identify five out of eight categories of reflective writing automatically. Although the accuracy was slightly lower than manual analysis, his work has provided the initial foundation on reflective writing analytics. These studies indicate that AI in writing is not confined only to software development; there is also an increasing interest in expanding the capability of AI approaches.

However, it is noteworthy that studies on adaptive systems for teaching and learning in higher education do not seem to focus on research writing thus far. The use of the adaptive system is still related to providing academic advice to students (Alfarsi et al., 2017), supporting university career services (Nguyen et al., 2018) and enhancing learning management systems with features that can recommend personalized contents to students (Kose & Arslan, 2016). Adaptive systems for research writing can be said to be still in their infancy but with great potential, as they allow students to obtain intelligent feedback rather than rule-based outputs. Ocharo and Hasegawa (2018) introduced an adaptive system for academic writing, which was developed on the basis of cognitive apprenticeship theory. It contains modules for modelling, coaching and scaffolding. From the students' initial drafts to the final drafts, the system is capable of offering feedback and guidance adaptive to the cognitive needs of the students. The adaptive interface is shown to students based on the initial skill-level estimation engine, whereby students are classified into novice, intermediate and advanced. Necessary guidance is then presented to students based on the estimated skill level.

This review of the studies related to the use of AI in research writing has demonstrated not only its wide-ranging adoption but also its importance in guiding students and novice writers. Most of the tools reviewed were not commercially released but have provided valuable input on various uses of AI approaches in guiding research writing. However, due to the advancement of cloud computing and web development, AI-based tools for research and academic writing are now easily accessible. The following section will present some of the popular AI-based tools in terms of their features and affordances.

9.4 FEATURES AND AFFORDANCES OF AI-BASED TOOLS IN RESEARCH WRITING

The AI-based tools for research writing released publicly either in the form of freeware or premium software can be largely categorized into three scopes: language and mechanics, text summarizing and synthesizing, and formatting and typesetting.

9.4.1 LANGUAGE AND MECHANICS

NLP and rule-based engines allow tools for language checking to be developed. These tools help users identify errors in language (grammar and sentence structures) and mechanics (such as punctuation, capitalization, abbreviations). The first popular tool in this category is Grammarly. It comes in free and premium versions and is largely used as a language checker. It can be used as a plugin on a browser or popular word processing software such as Microsoft Word (Fitria, 2021). As shown in Figure 9.1, Grammarly has several metrics that indicate the writing quality from correctness (accuracy in terms of spelling and grammar) to engagement and clarity. Driven by corpus-based databases and NLP, Grammarly's capability has shown tremendous improvement thanks to the increasing corpus size for deep learning to be implemented.

Mispellings and grammatical errors can effect your credibility. The same goes for misused commas, and other types of punctuation. Not only will Grammarly underline these issues in red, it will also showed you how to correctly write the sentence.

Underlines that are blue indicate that Grammarly has spotted a sentence that is unnecessarily wordy. You'll find suggestions that can possibly help you revise a wordy sentence in an effortless manner.

But wait...there's more?

Grammarly Premium can give you very helpful feedback on your writing. Passive voice can be fixed by Grammarly, and it can handle classical word-choice mistakes. It can also help with inconsistencies such as switching between e-mail and email or the U.S.A. and the USA.

It can even help when you wanna refine ur slang or formality level. That's especially useful when writing for a broad audience ranging from businessmen to friends and family, don't you think? It'll inspect your vocabulary carefully and suggest the best word to make sure you don't have to analyze your writing too much.

- commas - Remove the comma
- punctuation - Remove a space
- , - Add the word(s)
- showed - Change the verb form
- to correctly write the sentence - Unsplit the infinitive
- a sentence that is unnecessarily w... - Remove wordiness
- possibly - Remove redundancy
- revise a wordy sentence in an eff... - Change the wording
- ... - Remove the ellipsis
- very helpful - Choose a different word
- classical - Change the word

FIGURE 9.1 The Grammarly Document Checking Interface.

● FLUENCY

~~classical~~ → classic typical

It appears that the adjective **classical** may not be the right word to go with the noun **mistakes**. Consider using a different adjective.

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FIGURE 9.2 The User-Friendly Feedback Boxes in Grammarly.

Grammarly’s main affordance is in its simplicity in offering necessary language checking (Syafi’i, 2020). Another affordance is in terms of its accuracy. It has been studied to be more accurate than other language tools (which are built using simple rule-based engines). Sahu et al. (2020), for example, compared Grammarly with four other apps, and noted Grammarly to be the most accurate one, although it still has problems semantics and complex sentence structure. Grammarly also provides explanations for suggestions that it gives to the user, as shown in Figure 9.2. This feature helps users decide whether changes are necessary so they do not blindly accept all the suggested corrections by Grammarly.

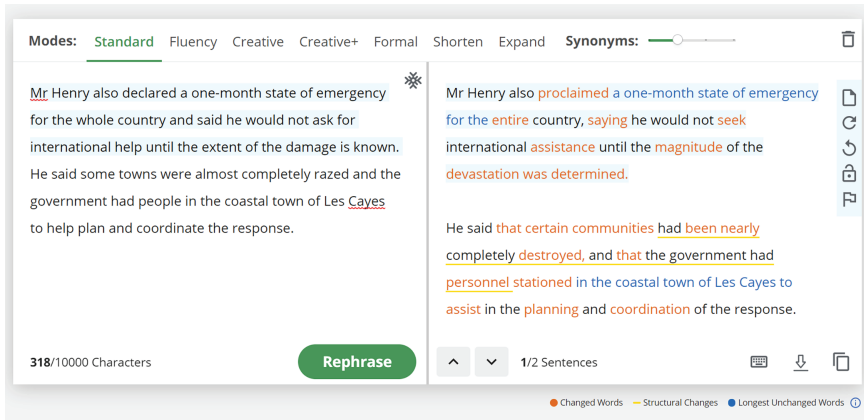


FIGURE 9.3 The Web Version of QuillBot.

Another popular AI-tool for language is Quillbot, which is known as an “intelligent” paraphrasing tool. Similar to Grammarly, it is offered in two versions: free and premium. The free version has a limit in terms of the number of words that can be input. It was first introduced as a paraphrasing helper but it has now incorporated a summarizer and grammar checker as well. Primarily, its strength is still in terms of paraphrasing, as the tool comes with several affordances that does not exist in other tools, as shown in Figure 9.3. The first affordance is to select the modes of paraphrasing; whether the users want to focus on fluency or more creative use of language. Quillbot is capable of paraphrasing sentences provided into different styles. The second affordance is the feature to decide the number of words that users want to change (synonym percentage). This option is helpful as it allows users to control the suggested outputs so that not all words are changed randomly to maintain the original meaning. The third affordance is the feature to expand and shorten what was provided in the original text. A text can be expanded and shortened without changing the meaning, allowing users to find different possibilities of writing the same concept. Finally, the fourth interesting affordance is its ability to provide other analytical tools, namely, comparing paraphrased texts according to different modes, and word and sentence count.

While QuillBot seems to offer many useful features, it is worth noting that most of the affordances mentioned earlier are only available in the premium version. Studies that examine QuillBot’s effectiveness and usefulness are also limited. In a study by Inayah and Sulistyaningrum (2021), they found QuillBot to be helpful in helping students overcome difficulties in paraphrasing, as it is often perceived as a challenging task in research writing. Nevertheless, they also noted that due to the convenience of generating paraphrased texts, students tend to directly copy the output without confirming whether the meaning is retained.

The two AI-based tools for language and mechanics mentioned are still very useful especially for researchers or writers who may be pressured to produce a writing in a short period of time. These tools would be able to assist them to be more efficient though they should be vigilant in cross-checking the accuracy of the tools.

9.4.2 TEXT SUMMARIZER AND SYNTHESIZER

One of the most challenging tasks in research writing is in performing a literature review. In order to produce good research writing, a solid review of previous studies and related literature is necessary. In this case, one popular tool is Scholarcy. The AI-powered article summarizer can quickly scan an article and provide the needed synopsis beyond the abstracts (refer to Figure 9.4). It reads the articles and breaks them down into easily readable sections so that users can assess how important the article is without having to read the whole text (Klucevsek & Brungard, 2020). Although it will not automatically write the review for the users, this tool is widely used for filtering articles and helping researchers to efficiently pick the most relevant articles for their research writing.

The effectiveness of this tool remains debatable since it still largely depends on the keywords used in the articles. For example, if a section in an article does not follow the usual convention of research writing, Scholarcy would have problems summarizing the correct information. An affordance of this tool is that it also comes with a reference and literature review manager. Users can manage downloaded or bookmarked articles easily in the app and get the synopsis of each article directly as shown in Figure 9.5. Scholarcy does seem to offer intriguing affordances to researchers and students, particularly in its ability to rapidly scan through texts and offer necessary output via its deep reference mining feature.

Iris.ai is another AI-based tool that is capable of summarizing and synthesizing texts. It boasts itself as the world-leading AI engine for scientific text understanding, which can be applied for the purpose of literature reviews, data extraction and tasks that require the processing of a large number of documents. Offered in free and premium packages, Iris.ai is still pretty new in the market but has built its reputation in its corpus-based NLP engine and intuitive visualizations, as shown in Figure 9.6 and Figure 9.7.

The primary affordance of Iris.ai is in its capability to transform what was found in research articles into neatly presented categorization and mapping (Extance,

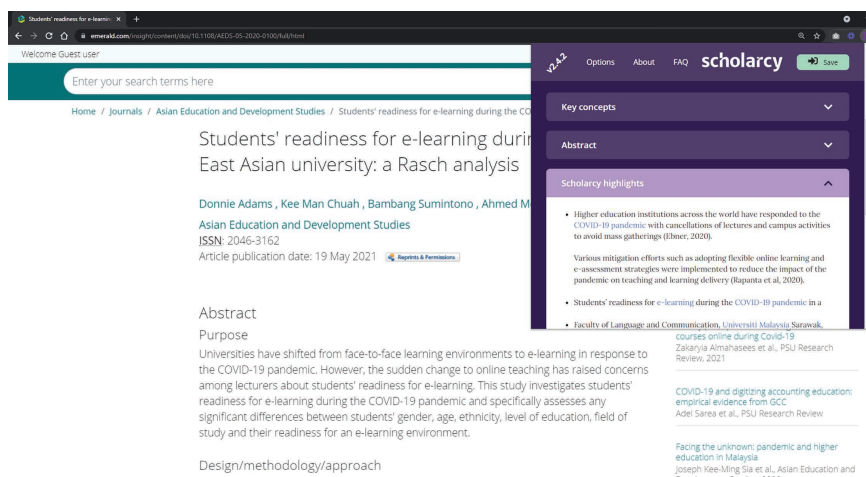


FIGURE 9.4 The Scholarcy Plug-In on Chrome Browser.

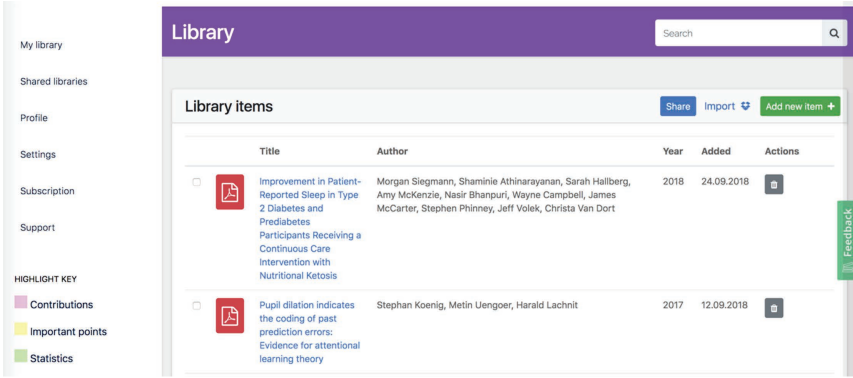


FIGURE 9.5 The Literature Review Manager in Scholarcy.

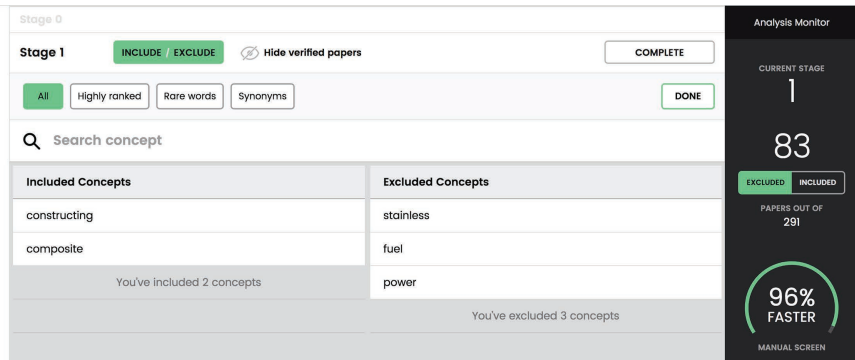


FIGURE 9.6 The Iris.ai Literature Search and Summary.

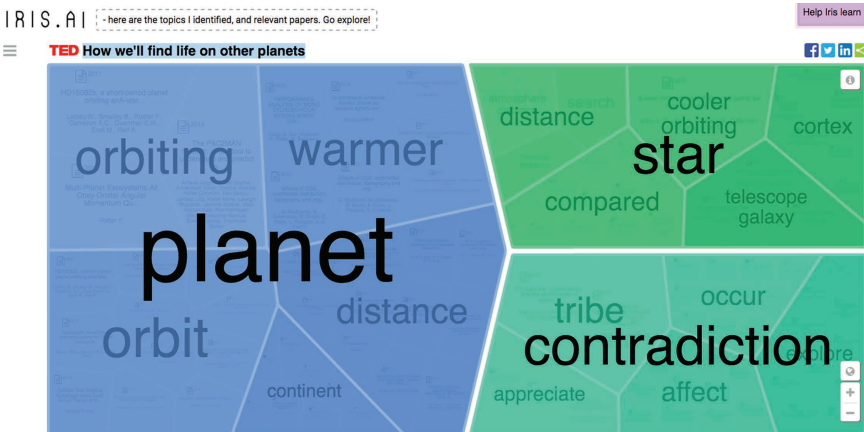


FIGURE 9.7 The Visualization of Identified Research Papers Based on Concepts.

2018). It also allows users to not only narrow down the reading list but also see each paper's relevance score to a stated problem statement. This feature is indeed powerful in assisting researchers to save more time in finding the relationships between documents. Another affordance of this tool (the premium version) is its pre-included data with access to more than 200 million papers. In other words, researchers do not have to spend time finding the papers or data from different databases as the search can be done directly through Iris.ai. All the filtered research papers are then compiled within Iris.ai for deeper checking, especially in terms of the parameters set by the users. Due to its pricing, Iris.ai seems to be more affordable to researchers rather than students. Although it provides a discounted rate for students, the price range is still relatively high. Thus, the opportunity for students to fully utilize this tool is limited. The free version is still sufficient for students to perform a basic literature search and obtain necessary summaries.

9.4.3 TYPESETTING

Another main problem in research writing is in terms of fulfilling different format and typesetting pre-determined by various publishers. While LaTeX tool is widely used in academia for handling typesetting (Baramidze, 2013), its programming-like commands and interface tend to be confusing to beginners. Typeset.io is created to overcome this problem. This web-based tool allows users to select a format of their choice (for example, paper format for a specific journal in major databases like IEEE or Springer) and upload their content to be converted to the required format instantly. As shown in Figure 9.8, once the user selects a paper format for a journal, they can immediately upload their content in Microsoft Word to be converted into the right format. It also allows editing to be made online directly.

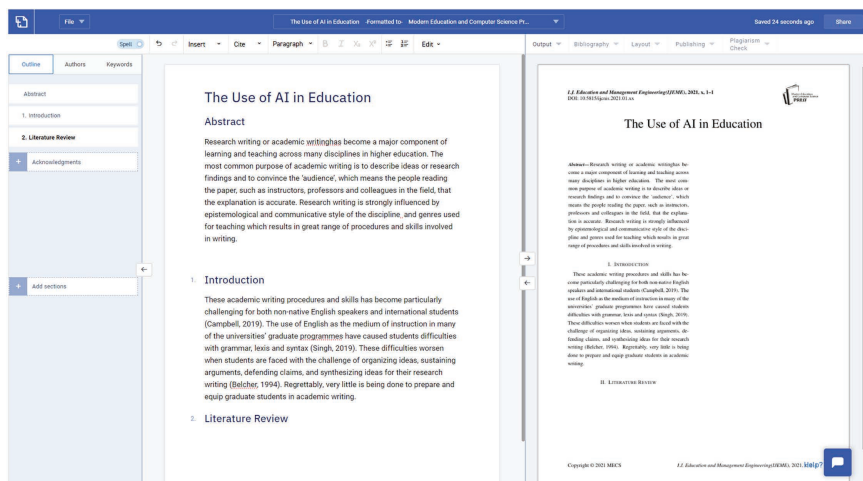


FIGURE 9.8 Typeset.io Sample Template for a Journal.

Typeset.io is by far the most convenient tool for typesetting, and though it does not use high-end Artificial Intelligence, its ability to detect key sections and learn to match them within the uploaded content can still be considered useful in research writing. Its large selection of different journals' format requirements is indeed another affordance that can benefit researchers and students.

9.5 FUTURE POTENTIALS

The tools reviewed in the previous sections have provided valuable insights into how AI-based tools can assist research writing. The process of writing any research publication is not simple and straightforward for many beginners and students. Tools that make use of AI and its corresponding technologies and approaches are beneficial. Future development and implementation of AI in research writing should focus on several potential areas. The first area is developing tools grounded on pedagogical features in which guidance is given in a more instructor-like manner (Shum et al., 2016). As learners require advice to produce good writing, suggestions and comments can be offered through a method that considers pedagogy. For instance, instead of directly suggesting a sentence to be changed, the tool can provide some guiding questions that would inform the system to offer adaptive responses to the learners.

Additionally, future development of AI-based tools for research writing should prioritize macro-level issues and process-oriented writing (Strobl et al., 2019). Most of the tools thus far focus on micro-level issues such as spelling errors, sentence structure and mechanics. There is a huge potential to optimize the use of AI in guiding learners to manage issues concerning cohesion and coherence, argumentative quality and diction or tone. As research writing must be unbiased and objective, the aspect of sentiment analysis in these tools should be given more attention as well. This would help not only students but also researchers to be aware of the claims or statements made.

Developers of AI-based tools for research writing can also consider the incorporation of conversational bots or chatbots. Although it may seem like a mismatch since chatbots are speaking and reading, the informal nature of chatbots can enhance writing instructions by lowering the affective filters (Lin & Chang, 2020). Since writing is often perceived as a difficult skill, using chatbots would be able to simulate the presence of a teacher in assisting them in writing. This inclusion can potentially reduce their anxiety and lead to positive emotional impacts in learning how to write research papers.

The future potentials of enhancing AI adoption in developing research writing tools is driven by the development in AI itself. As AI technologies and approaches become more advanced and cheaper, the developed tools can, therefore, deal with more complex problems in research writing. There are, however, several constraints that need to be given attention. Firstly, no matter how sophisticated an AI-based tool would be, the elements of semantics and pragmatics are still dependent on contexts, which can change drastically. Machine learning would need to cope with the changes in how certain words or sentences are used to convey certain meanings. As emphasized by Labov (2018), many words with newly found meanings or usages are no longer restricted by geographical constraints. The usage of "avant garde" terms

makes it even more difficult for machine learning to “decode” the correct meaning. This shortcoming highlights the need for more in-depth research using more robust algorithms in dealing with the complexity of natural language use. Deep learning beyond the Bayesian methods such as deep belief network (Huang et al., 2019) is showing great promise in understanding language use from large corpus. Secondly, AI-based research writing tools need to cope with requirements of different fields, as each field may have a set of expectations to be addressed. For example, research writing in the medical field is quite different from that in humanities. Thirdly, it is pivotal for developers of AI-based research writing tools to offer formative feedback, which are meaningful, rather than a repetitive pre-determined feedback. Meaningful feedback is indeed necessary for the development and enhancement of research writing skills. Despite the constraints, it would be interesting to see how AI continues to develop in the future and play its role in the area of research writing.

9.6 CONCLUSION

The area of research writing or academic writing in general may seem trivial but its impact in promoting scholarly sharing and dissemination of knowledge cannot be taken lightly. This chapter has provided useful insights on how knowledge and technicalities of AI can lend a hand in elevating the effectiveness of research writing tools. More empirical research should be conducted to validate the tools as well. Additionally, future potentials of AI implementation for complex research writing are also presented. Despite the excitement of easing the process of research writing, this area should also give more weight to ethical issues such as plagiarism and research fabrication. The development of better cognitive processes for AI intelligent systems would definitely help to prevent academic dishonesty or unethical practices in research writing. It is important to counter the notion that AI-based tools are going to turn research writing into an automatic factory-like process without much intellectual consideration. In terms of pedagogical implications, the AI-based tools should not be used as a direct replacement of instructors’ role in offering personalized and meaningful feedback to the learners. They are to be used cautiously as supplementary tools to assist instructors in managing writing instruction and effective assessment of research writing. In essence, learners still must master the knowledge and skills of research writing and use available tools to facilitate the process.

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