Art. #2540, 8 pages, https://doi.org/10.15700/saje.v44n4a2540

Towards a taxonomy of artificial intelligence in teaching writing in a foreign language

Jesús García Laborda
Instituto Franklin, Universidad de Alcalá, Alcalá de Henares, Spain
jesus.garcialaborda@uah.es
Teresa Magal Royo
Universitat Politécnica de Valencia, Valencia, Spain
Slavka Madarova
Universidad Politécnica de Madrid, Madrid, Spain

The use of artificial intelligence in foreign language teaching, and particularly in teaching writing, is still under investigation for its potential positive impact and potential benefits. So far, the focus was on controversial uses, due to the challenges for the teachers. However, when used just for learning purposes, it can be a facilitating tool for the students. The key now is to understand its effects, challenges, and opportunities, to establish a framework for its use, and to make teachers aware of its potential. To this end, in this article we take a functional and utilitarian approach by identifying the characteristics and capacities of currently available sites. A description of the different sites is given along with their advantages and disadvantages. Since only a few fundamental works have been published on the subject, we propose a taxonomy with examples, evaluate its benefits and drawbacks and suggests potential applications for teaching and research.

Keywords: AI applications; artificial intelligence (AI); facilitation; higher education; language learning; taxonomy; writing process

Introduction

Chat PGT 3.0 revolutionised the field of education at the end of 2022 (Crompton & Burke, 2023; Dianova & Schultz, 2023) and we need to adapt to this new reality (García-Peñalvo, Llorens-Largo & Vidal, 2024). However, different forms of artificial intelligence (AI) have been used for over 50 years (Nwosu, Bereng, Segotso & Enebe, 2023). In the 1990s and early 2000s, master systems were used for medical purposes (Salem, 2000). At that time, the dramatic changes that would occur mostly in the fields of business and science were foreseeable but only to a limited extent in education (Scandura, 2010). Then, teachers worldwide could not have imagined that its impact would change the way we understand assessment (Jimenez & Boser, 2021) and, overall, education (McArthur, Lewis & Bishary, 2005) worldwide (Echedom & Okuonghae, 2021). The initial reaction to its powerful effect on evaluation and instruction was a fierce rejection (Istenic, Bratko & Rosanda, 2021; So, Jang, Kim & Choi, 2024). Teachers perceived that the new (or not so new) generative AI could have a significant effect on academic ethics (Cooper, 2023; Su & Yang, 2023; Swindell, Greeley, Farag & Verdone, 2024). In fact, authors like Bannister, Alcalde Peñalver and Santamaría Urbieta (2024) claim that the changes in learning also require integrity self-awareness since the measures to avoid fraud are limited in most countries to eliminate this current idea that ideas lack authorship as presented by some AI tools (Duah & McGivern, 2024). This was also an issue observed in South Africa and elsewhere during and after the coronavirus disease (COVID-19) pandemic (Jili, Ede & Masuku, 2021) but, has become prevalent due to the significant effect produced by the coming of generative AI. This is just an addition to the commonly denounced situation of corruption in a few South African universities (Ngcamu & Mantzaris, 2023). The natural way in which some unscrupulous students looked at it increased the already existing concerns about the legality of some tasks that were produced in schools and universities (Aldridge, 2018). Therefore, some teachers have objected to the initial acceptance of the new technology (Romero-Rodríguez, Ramírez-Montoya, Buenestado-Fernández & Lara-Lara, 2023). Of course, AI in diverse forms has been present in education and everyday life for years, but it was the strong generative intelligence that really mattered since it was able to generate acceptable papers that students could submit as their own. The main issue is that generative AI can sometimes provide wrong, false or biased data (Bozkurt, Xiao, Lambert, Pazurek, Crompton, Koseoglu, Farrow, Bond, Nerantzi, Honeychurch, Bali, Dron, Mir, Stewart, Costello, Mason, Stracke, Romero-Hall, Koutropoulos, Toquero, Singh, Tlili, Lee, Nichols, Ossiannilsson, Brown, Irvine, Raffaghelli, Santos-Hermosa, Farrell, Adam, Thong, Sani-Bozkurt, Sharma, Hrastinski & Jandrić, 2023).

Thus, the importance of generative AI has become a driving force in education (Kong & Yang, 2024). However, its potential positive effects on education and teacher support are still being explored (Holstein, McLaren & Aleven, 2019). Despite this, it has provoked the interest of all educational stakeholders, not just students who see it as a facilitative tool for their studies but also other stakeholders who cannot establish a framework for its use. Indeed, the most important aspect now is to become familiar with its effects, challenges, and opportunities, not to be afraid but to use it constructively for positive learning purposes. Teachers also need to become aware of its potential to better assess their students. In order to do so, we show a functional and utilitarian approach through the indication of the properties and capacities that current available AI sites have. A

description of the different sites is provided with their benefits and disadvantages. We propose a taxonomy with examples, then discusses the benefits and drawbacks and suggest possibilities for further use of AI in the classroom and academia. Therefore, the research questions (RQ) are:

RQ1. What are the most common AI applications currently used to improve writing?
RQ2. What are their functions and benefits?

Literature Review

The interest of using generative AI for writing in education has seen an increase since 2022 (Maphoto, Sevnarayan, Mohale, Suliman, Ntsopi & Mokoena, 2024). However, very few papers have intended to create a taxonomy of AI to facilitate the process of writing. Most literature addresses academic fraud when writing papers or dissertations and how to avoid it (Campbell & Cox, 2024; Meng & Ma, 2023). In order to do this literature review, a search with the keywords "generative artificial intelligence" AND "academic writing" run on the Education Resources Information Center (ERIC) database on 18 December 2023 and 2 October 2024 yielded 17 results. Since we considered this number to be too low, we conducted the search in combination with 11 more databases, resulting in 32,464 hits. Bahroun, Anane, Ahmed and Zacca (2023) state that the number of papers has increased significantly in the last 3 years. However, it was observed that very few showed a real positive educational approach. For instance, Salinas-Navarro, Vilalta-Perdomo, Michel-Villarreal and Montesinos (2024) consider its positive value and limit generative AI tools to mere "agents-to-write" with the only goal to facilitate the expression of contents in an accurate form (Yeo, 2023). Codina (2024) suggests that there are two ways in which AI facilitates academic writing: verification and evaluation (Barrett & Pack, 2023). Other functions include grading, asking questions and others of which the training and utilities fall outside the scope of this article (Bonner, Lege & Frazier, 2023; Escalante, Pack & Barrett, 2023). Verification refers to the process of gathering and organising data, such as checking for factual accuracy, quality of sources and quantity of sources, whereas evaluation examines the writing, structure and relationships within and outside the writing process**.**

Objectives

The current uses of AI in education are for profiling and prediction such as admission decisions, counselling towards avoidance of early drop-out and thus facilitation of academic success. In order to do so, intelligent tutoring systems for course content, feedback, materials design and student-teacher collaboration are used. Accordingly, similar systems are used for assessment and evaluation. Given the results from assessment, tools can suggest course content changes, personalised support and short- and long-term learning analytics. In relation to academic writing, we still have to discover what the main functions are.

Method

To design the taxonomy of AI applications, the model by Codina (2024) was initially used. A functional approach was considered based on what the applications could do for us. The purpose of this taxonomy was to make teachers and educators aware of the types of tasks that could be performed by these applications for two purposes: 1) to control their ethical use and 2) to develop the basic skills and knowledge to prevent them (teachers) from being deceived. The taxonomy based on the properties is generic and responds to traditional specifications of what an academic paper should include according to the American Psychological Association (APA) research publication (2014).[i] These parts can easily be understood by the practitioners and are certainly intended to be useful, accessible and recognisable. Each category is identified according to its functionality and educational value. In order to do our taxonomy, we did a variation of Fink's taxonomy of significant learning to create more meaningful and lasting learning experiences. In order to adapt the new criteria, we consider the original including, foundational knowledge, as we considered writing applications that can help users acquire essential facts and concepts. Fink's taxonomy of significant learning (Fink, 2003) is a framework designed to create more meaningful and lasting learning experiences. It can be applied to writing tools to enhance the learning process in several ways.

Foundational knowledge: Writing tools can help users acquire essential facts and concepts. For example, grammar checkers and style guides provide foundational knowledge about language rules and writing conventions.

Application: These tools can assist users in applying their knowledge by offering features like real-time feedback, writing prompts, and templates. This helps users practice and refine their writing skills.

Integration: Writing tools can facilitate the integration of ideas by allowing users to organise their thoughts, create outlines, and link related concepts using tools like mind mapping software and citation managers.

Learning how to learn: Writing tools can teach users strategies for effective writing and self-assessment. Tutorials, writing courses, and adaptive learning platforms can guide users in becoming more self-directed learners.

Application: These tools can assist users in applying their knowledge by offering features like real-time feedback, writing prompts, and templates. This helps users practice and refine their writing skills.

Integration: Writing tools can facilitate the integration of ideas by allowing users to organise their thoughts, create outlines, and link related concepts. Tools like mind mapping software and citation managers are particularly useful here.

Based on these features, we considered the following factors to classify each category:

a) Distinctiveness: containing non-overlapping functionalities and not serving more than one function (although some applications can be used for more than one)
b) Comprehensiveness: covering all the possible functions of a text
c) Usefulness: aiming at helping teachers identify the different parts of the text

Accordingly, the following categories were established:

1) Summary
   a) Abstracts
   b) Conclusions
   c) Objective design
2) Improvement
   a) Re-writing
   b) Revision and formatting
3) Sources
   a) Mind maps
   b) Reference search
   c) Avoidance of plagiarism

AI Applications in Writing: Key Features

In general, we distinguish between strong and weak generative AI, although in this case we prefer the differentiation between total and partial AI. At first, we looked at applications that generate full papers such as generative pre-trained transformer (GPT)-based applications like AI chat bot writers, for example Essay GPT, essai.ai, Jenni AI and more. These applications offer a number of possibilities, genres and styles for output depending on the performance of their algorithms and the refinement of the application. Obviously, these generators have received a lot of attention and there is special interest in detecting different forms of ethical issues, especially plagiarism (in various forms). However, here we focus on weak (or not so weak) forms of generative AI that do not claim to do all the work but rather, through specific training, address certain needs or provide specific support to their users.

In order to classify the applications, the possibility of using them in regular instruction was considered of vital importance. As stated in the introduction and in the literature review, AI applications tend to be considered for their ease of use for fraudulent purposes, but they can also be a system for obtaining suggestions to improve the ability to communicate (Cardona, Rodríguez & Ishmael, 2023; Kaban, 2023; Mena-Guacas, Urueña Rodríguez, Santana Trujillo, Gómez-Galán & López-Meneses, 2023; O'Dea & O'Dea, 2023; among others).

For this analysis, three factors were considered that could potentially serve to categorise new applications. The factors are as follows.

1) Access*:* Two main forms of access have been observed. The first was part of or in addition to other programs, such as the add-ins for suites (e.g., in the case of Microsoft (MS), formerly known as Office Applications [Apps]) or browsers, while the second corresponds to the usual standalone ones, either as mobile applications or as proper sites.
2) Payment*:* The first obvious distinction is whether it is free of charge/paid (fee required). However straightforward this distinction might be, we all know that, in certain cases, payment may not mean a sum of money charged to your credit card. In more than a few cases, it is the permission to access your personal data via your mobile phone that represents another form of payment.
3) Tasks*:* What each application can do and what it aims to achieve.

In relation to access, we did not aim to provide an exhaustive compilation of websites, but rather to examine specific examples that fit the intended functions. In general, numerous options beyond those mentioned here exist. To present the various applications, we categorised them according to the previously discussed taxonomy. This classification focuses solely on websites available on the internet.

Classification of Internet Applications/Websites

The classification of these websites should be known before using any of the applications for educational use by both instructors and students. When both stakeholders understand why and when to use the applications, a positive effect can be expected (Slimi, 2023). This also assumes good practices of technology for learning purposes and motivates their use.

Summary applications

They are the most common and serve a variety of purposes, from summarising a text to comprehension, but another benefit can be creating good abstracts and conclusions. In academic writing, summarising can be one of the most complex functions, since all relevant information must be included and there are also standardised formulas for each individual field. For instance, a linguistics abstract may differ significantly from a science abstract. SciSummary (fee required) is an application that is used by many universities to summarise research papers. Researchers are then advised to revise and enhance the summary to produce an abstract. However, Paperpal (partially free of charge) can be used both online and also as an add-in to MS Word. It also allows to check for plagiarism. For concluding and revising, EditPad

(partially free of charge) does the double job of writing and concluding, while also checking for potential plagiarism. These functions can also be performed by sites such as Grades Fixer.

A second possibility is to require the AI application to state the objectives, as this can provide a robust framework for the paper. Since AI applications are capable of identifying the different sections through statistical processes (Deshpande & Kumar, 2018; Wang, 2021), they also favour the inclusion of the most significant parts. For this purpose, applications like HyperWrite (fee required) are particularly indicated to improve the quality of writing – although their potential goes beyond writing and relates to a number of business tasks. For adapting and summarising texts, Parafrasist (fee required) has considerable potential, which includes creating essays and correcting spelling and style.

Improvement

Improvement is probably the best feature of many applications aimed at writing. There are two main ways in which academic writing can be improved: a) by revising style, grammar and internal cohesion; and b) by checking and modifying the text so that anti-plagiarism applications are unable to detect it. In relation to the first, Wordtune (fee required) serves to generate text, but more importantly, it is an excellent editor. Smodin (partially free of charge with a limitation of use) has the ability to rewrite texts, generate essays, summarise and check for plagiarism issues. Regarding the second aspect, Undetectable (partially free of charge with a limitation of use) is specifically designed and trained for preventing plagiarism and checking. An interesting case is WriteHuman (partially free of charge with a limitation of use), of which the main function and use is to make texts resemble human writing. Obviously, this is considered unethical when used to produce a piece of work for grading.

Sources

These applications serve to help researchers find everything from bibliographies to websites. However, it is important to note that these resources are often limited to open access bibliography and other open access materials available online. Therefore, most historical and fundamental resources which cannot be found online may not be included. Another issue is that it does not check the validity of the information (Shukla, 2018) but the proximity (in time), even when the accuracy of the references may be debatable. The most recognisable is Connected Papers (partially free of charge with a limitation of use) that not only provides references but also visually connects them through connection trees. This advanced system allows searches by all the identifiers used by regular databases. Two other valuable tools are Chatsonic (fee required) and GitMind (fee required). Chatsonic is similar to ChatGPT and can be used to create theoretical frameworks, while GitMind can be used to create concept or mind maps.

Educational Uses of AI for Writing in a Foreign Language

Over the last few years, process writing has gained a significant position in teaching (Carter, 2023). Process writing is based on two crucial concepts: firstly, that providing informed feedback and adequate revision of texts leads to improved writing, and secondly, that in order to improve writing, it is necessary to have adequate models (Tarin & Yawiloeng, 2023). This is usually the case in the first language, but the importance of well-designed models and the re-writing process are even more important in a second or foreign language, since students may lack the adequate mental schemata to create near-native or even native-like productions (Luo, 2022). According to Morgan (2015), writing, but more specifically, technical writing, includes five main steps, namely, planning, structuring, writing, reviewing/revising and publishing. In approaching writing for academic purposes, we apply that model here.

a) Planning. The section on sources above provides a number of websites that can be used at this stage, most of which outline the ideas and sections that the paper should follow. Often, even experienced writers may fail to express some of the sub-sections such as definitions, methodology, etc. Generative AI provides standardised structures that students can follow. This can include the definition of scope, audience, genre, style, length, and tone. Generative AI applications can support students of all levels from beginners to advanced learners by showing when and how to introduce all this information in two ways. Firstly, by providing clear mind maps which can be enriched by the use of an accurate reference-tree, and secondly, by creating simple models that the learner can enrich in a second stage. In fact, human intervention is necessary to determine what the student is expected to address. Additionally, at least in higher education, students need to inform themselves and gather information that they can easily access using information devices, such as online or print publications, which they must revise and critically evaluate from various perspectives. Thus, instructors should require students to provide proof of their progress to ensure that the entire writing process is adequately implemented. These outputs should include a well-founded outline, a research record and an observable matrix or worksheet. In a long paper, these can be included as appendices.
b) Structuring. In this second part students should describe the different topics or sections which are included in the piece of writing. This part can be complemented by the inclusion of sources or at least links to those sources. This not only serves the teacher to observe the research process followed by

the student, but also to create sound frameworks for the written output. AI applications can provide the correct model to follow. It is essential that students provide evidence of their writing progress (not just the final product) to verify the thinking and composition process. This can be cross-checked against the worksheet provided in the first part. An adequate input for this stage would be a table of contents. This can include a brief list of ideas in each section that will be followed up in the next stage.

c) Writing. This is the obvious section, that generative AI, for limited amounts of money, can create the adequate text that can fit in this section. Teachers may require multiple drafts since it is very difficult to achieve decent output without significant changes and revisions. In many cases, unfortunately, teachers may have limited time to revise this creative process, but special care must be taken at this stage and in the following ones. After the writing of these drafts, which may be subject to revision by the teacher, the students can proceed to the review stage.

d) Reviewing/revising. The review section can be significantly enhanced by the use of AI as demonstrated earlier. AI can do an excellent job of checking and editing, revising writing, suggesting potential changes, reviewing and even grading papers (e.g., Grammarly or QuillBot). Once students receive feedback, they can edit their initial checklist, get the editing output and respond to the teacher's comments.

e) Publishing. In this case, the expected output can range from a simple essay to a full article. It is expected that all the previous steps have been completed at this last stage.

In principle, the writer (the student) should have followed these steps. However, many teachers are afraid when students decide to submit papers without strict measures of control. For instance, one of the researchers recently received a request from a student who wanted to turn in their final degree project with only a few theoretical principles and without any supervision from the professor. That obviously raised suspicion and led the instructor to translate significant chunks of the paper from Spanish to English just to find that the ethical integrity of that work had been challenged. Thus, it is important to point out what safety measures teachers should consider nowadays when asking students to prepare long pieces of writing (or even smaller ones) in a foreign language. This is particularly relevant, as in the case mentioned above, in the teaching of academic writing in a foreign language where a student may perform above their expected or known competence. Many students have tried to deceive their instructors by asking applications to use child-like language but even in that case, common errors and differences can be perceived by trained instructors. Unexperienced students may mistakenly think that a 7-year-old native child does not differ from a high-intermediate student. However, young children exhibit consistency and several theories of first language acquisition of writing have provided features of length and systematicity in writing that are hardly found in learners of a foreign language.

Discussion

The use of AI in learning writing should not be ruled out but instructors should be aware of potential ethical and technical issues that may arise in the learning process, with plagiarism being a major concern that should not be overlooked (Wach, Duong, Ejdys, Kazlauskaitė, Korzynski, Mazurek, Paliszkiewicz & Ziemba, 2023). As stated in the introduction, teachers today are unsure of whether the outputs received from their students are entirely their own writing. While trained teachers may be able to detect unethical behaviour (Alexander, Savvidou & Alexander, 2023; Cingillioglu, 2023; Yan, Fauss, Hao & Cui, 2023), it might still be difficult to detect in some cases. Therefore, taking measures to ensure that what has been received from the students is really authentic is not only a need but a must. Teachers should have an integrative vision of the writing process and not only believe that the importance of the writing process should rely on the creative idea and the final output. Regardless of the time constraints on teachers due to an increasing load of bureaucracy in their daily lives and the need for personal and family time, it is not less important to oversee the whole writing process despite the time it requires. They should be able to look in depth at each individual stage suggested above and provide suggestions for revision and improvement. They should probably ask to see the writing plan and mind map, track changes from the first to the last draft and require complete sources, even if they come as comments accompanying the text. In addition, suggesting at least two ways to approach the paper structure, can also make the student more critical and thus benefits learning. It is important to review the content, being very collaborative and request responses to feedback even to minor details (even if the student may not always follow the suggestions). Finally, the final draft should be approved and the format and layout in the final version checked. Failing this, many would advocate going back to pen and paper.

Conclusion

The use of AI applications hereby presented (RQ1) in some of the stages, as it has been shown above can be very positive and help significantly, especially in sourcing information, formatting, adherence to style conventions and lexical choices (RQ2). While AI can aid in writing instruction, ethical concerns, particularly plagiarism, require careful attention. Teachers must ensure authenticity and monitor the entire writing process, from planning to final drafts. Despite time constraints, tracking changes, providing feedback, and

reviewing details are essential. Therefore, safeguarding the whole process may discourage learners from inappropriate conduct. In conclusion, there is still potential for cooperation between AI and learners that needs to be further explored. This article represents just one of the initial approaches to the topic and certainly more relevant and informed papers will follow. We advocate for more research on the topic. Future research should consider the inclusion of more websites, add-ins to document creation suites and other specific tips for teachers. It is believed that humans possess resilient attitudes, however, AI may offer more than what we may currently believe.

Acknowledgement

Doctor García Laborda would like to thank the Excellence Program of Universidad de Alcalá 3090XL574 EPU-INV-UAH/2022/004 for providing the funds for this research.

Authors' Contributions

GL, the lead researcher, was responsible for project management, defined the taxonomy structure for AI applications in writing, ensured consistency in writing and revisions, integrated contributions from others and wrote key sections (the taxonomy). TMR conducted a comprehensive literature review, sourced references, created an annotated bibliography, wrote the draft of the literature review section and revised the paper. SM focused on AI writing tools, categorised applications, analysed case studies, and wrote draft sections on the practical use of AI tools.

Notes

i. American Psychological Association 2014. *Publication manual of the American Psychological Association* (6th ed). Washington, DC: Author.

iii. DATES: Received: 27 February 2024; Revised: 3 September 2024; Accepted: 14 October 2024; Published: 30 November 2024.

References

Aldridge D 2018. Cheating education and the insertion of knowledge [Special issue]. *Educational Theory*, 68(6):609–624. https://doi.org/10.1111/edth.12344

Alexander K, Savvidou C & Alexander C 2023. Who wrote this essay? Detecting AI-generated writing in Second Language education in higher education. *Teaching English with Technology*, 23(2):25–43. https://doi.org/10.56297/BUKA4060/XHLD5365

Bahroun Z, Anane C, Ahmed V & Zacca A 2023. Transforming education: A comprehensive review of generative artificial intelligence in educational settings through bibliometric and content analysis. *Sustainability*, 15(17):12983. https://doi.org/10.3390/su151712983

Bannister P, Alcalde Peñalver E & Santamaría Urbieta A 2024. International students and generative artificial intelligence: A cross-cultural exploratory analysis of higher education academic integrity policy. *Journal of International Students*, 14(3):149–170. https://doi.org/10.32674/jis.v14i3.6277

Barrett A & Pack A 2023. Not quite eye to A.I.: Student and teacher perspectives on the use of generative artificial intelligence in the writing process. *International Journal of Educational Technology in Higher Education*, 20(1):59. https://doi.org/10.1186/s41239-023-00427-0

Bonner E, Lege R & Frazier E 2023. Large Language Model-based Artificial Intelligence in the language classroom: Practical ideas for teaching. *Teaching English with Technology*, 23(1):23–41. https://doi.org/10.56297/BKAM1691/WIEO1749

Bozkurt A, Xiao J, Lambert S, Pazurek A, Crompton H, Koseoglu S, Farrow R, Bond M, Nerantzi C, Honeychurch S, Bali M, Dron J, Mir K, Stewart B, Costello E, Mason J, Stracke CM, Romero-Hall E, Koutropoulos A, Toquero CM, Singh L, Tlili A, Lee K, Nichols M, Ossiannilsson E, Brown M, Irvine V, Raffaghelli JE, Santos-Hermosa G, Farrell O, Adam T, Thong YL, Sani-Bozkurt S, Sharma RC, Hrastinski S & Jandrić P 2023. Speculative futures on ChatGPT and generative artificial intelligence (AI): A collective reflection from the educational landscape. *Asian Journal of Distance Education*, 18(1):53–130. https://doi.org/10.5281/zenodo.7636568

Campbell LO & Cox TD 2024. Facilitating the research writing process with generative artificial intelligence. *Journal of the Scholarship of Teaching and Learning*, 24(2):104–109. https://doi.org/10.14434/josotl.v24i2.36580

Cardona MA, Rodríguez RJ & Ishmael K 2023. *Artificial intelligence and the future of teaching and learning: Insights and recommendations*. Washington, DC: US Department of Education, Office of Educational Technology.

Carter TJ 2023. Apples and oranges: Toward a comparative rhetoric of writing instruction and research in the United States. *College English*, 85(5):387–414. https://doi.org/10.58680/ce202332559

Cingillioglu I 2023. Detecting AI-generated essays: The ChatGPT challenge. *The International Journal of Information and Learning Technology*, 40(3):259–268. https://doi.org/10.1108/IJILT-03-2023-0043

Codina L 2024. *Evaluación de inteligencias artificiales generativas en trabajos académicos y profesionales: Una taxonomía básica* [Assessing generative artificial intelligences in academic and professional work: A basic taxonomy]. Available at https://www.lluiscodina.com/evaluacion-inteligencias-artificiales. Accessed 20 January 2024.

Cooper G 2023. Examining science education in ChatGPT: An exploratory study of generative artificial intelligence. *Journal of Science Education and Technology*, 32(3):444–452. https://doi.org/10.1007/s10956-023-10039-y

Crompton H & Burke D 2023. Artificial intelligence in higher education: The state of the field. *International Journal of Educational Technology in Higher Education*, 20(1):22. https://doi.org/10.1186/s41239-023-00392-8

Deshpande A & Kumar M 2018. *Artificial Intelligence for Big Data: Complete guide to automating Big*

Data solutions using Artificial Intelligence techniques. Birmingham, England: Packt Publishing Ltd.

Dianova VG & Schultz MD 2023. Discussing ChatGPT's implications for industry and higher education: The case for transdisciplinarity and digital humanities. *Industry and Higher Education*, 37(5):593–600. https://doi.org/10.1177/09504222231199989ç

Duah JE & McGivern P 2024. How generative artificial intelligence has blurred notions of authorial identity and academic norms in higher education, necessitating clear university usage policies. *International Journal of Information and Learning Technology*, 41(2):180–193. https://doi.org/10.1108/IJILT-11-2023-0213

Echedom AU & Okuonghae O 2021. Transforming academic library operations in Africa with artificial intelligence: Opportunities and challenges: A review paper. *New Review of Academic Librarianship*, 27(2):243–255. https://doi.org/10.1080/13614533.2021.1906715

Escalante J, Pack A & Barrett A 2023. AI-generated feedback on writing: Insights into efficacy and ENL student preference. *International Journal of Educational Technology in Higher Education*, 20(1):57. https://doi.org/10.1186/s41239-023-00425-2

Fink LD 2003. *Creating significant learning experiences: An integrated approach to designing college courses*. San Francisco, CA: Jossey-Bass.

García-Peñalvo FJ, Llorens-Largo F & Vidal J 2024. The new reality of education in the face of advances in generative artificial intelligence [La nueva realidad de la educación ante los avances de la inteligencia artificial generativa]. *RIED-Revista Iberoamericana de Educación a Distancia*, 27(1):9–39. https://doi.org/10.5944/ried.27.1.37716

Istenic A, Bratko I & Rosanda V 2021. Are pre-service teachers disinclined to utilise embodied humanoid social robots in the classroom? *British Journal of Educational Technology*, 52(6):2340–2358. https://doi.org/10.1111/bjet.13144

Holstein K, McLaren BM & Aleven V 2019. Co-designing a real-time classroom orchestration tool to support teacher–AI complementarity. *Journal of Learning Analytics*, 6(2):27–52. https://doi.org/10.18608/jla.2019.62.3

Jili NN, Ede CI & Masuku MM 2021. Emergency remote teaching in higher education during COVID-19: Challenges and opportunities. *International Journal of Higher Education*, 10(5):1–9. https://doi.org/10.5430/ijhe.v10n5p1

Jimenez L & Boser U 2021. *Artificial intelligence: Future of testing in education.* Washington, DC: Center for American Progress. Available at https://files.eric.ed.gov/fulltext/ED617052.pdf. Accessed 20 January 2024.

Kaban A 2023. Artificial intelligence in education: A science mapping approach. *International Journal of Education in Mathematics, Science and Technology*, 11(4):844–861. https://doi.org/10.46328/ijemst.3368

Kong SC & Yang Y 2024. A human-centered learning and teaching framework using generative artificial intelligence for self-regulated learning development through domain knowledge learning in K–12 settings. *IEEE Transactions on Learning Technologies*, 17:1588–1599. https://doi.org/10.1109/TLT.2024.3392830

Luo X 2022. The effect of manipulating task complexity along resource-dispersing dimension on L2 written performance from the perspective of complexity theory. *English Language Teaching*, 15(9):151–159. https://doi.org/10.5539/elt.v15n9p151

Maphoto KB, Sevnarayan K, Mohale NE, Suliman Z, Ntsopi TJ & Mokoena D 2024. Advancing students' academic excellence in distance education: Exploring the potential of generative AI integration to improve academic writing skills. *Open Praxis*, 16(2):142–159. https://doi.org/10.55982/openpraxis.16.2.649

McArthur D, Lewis M & Bishary M 2005. The roles of artificial intelligence in education: Current progress and future prospects. *Journal of Educational Technology*, 1(4):42–80. Available at https://files.eric.ed.gov/fulltext/EJ1068797.pdf. Accessed 20 January 2024.

Mena-Guacas AF, Urueña Rodríguez JA, Santana Trujillo DM, Gómez-Galán J & López-Meneses E 2023. Collaborative learning and skill development for educational growth of artificial intelligence: A systematic review. *Contemporary Educational Technology*, 15(3):ep428. https://doi.org/10.30935/cedtech/13123

Meng H & Ma Y 2023. Machine learning-based profiling in test cheating detection. *Educational Measurement: Issues and Practice*, 42(1):59–75. https://doi.org/10.1111/emip.12541

Morgan K 2015. *Technical writing process: The simple, five-step guide that anyone can use to create technical documents such as user guides, manuals, and procedures*. St Leonards, Australia: Better on Paper Publications.

Ngcamu BS & Mantzaris E 2023. Corruption detection systems and skills, and employee retention in South African universities. *Journal of Academic Ethics*, 21(3):519–539. https://doi.org/10.1007/s10805-022-09466-0

Nwosu LI, Bereng MC, Segotso T & Enebe NB 2023. Fourth Industrial Revolution tools to enhance the growth and development of teaching and learning in Higher Education Institutions: A systematic literature review in South Africa. *Research in Social Sciences and Technology*, 8(1):51–62. https://doi.org/10.46303/ressat.2023.4

O'Dea X & O'Dea M 2023. Is Artificial Intelligence really the next big thing in learning and teaching in higher education? A conceptual paper. *Journal of University Teaching and Learning Practice*, 20(5). https://doi.org/10.53761/1.20.5.05

Romero-Rodríguez JM, Ramírez-Montoya MS, Buenestado-Fernández M & Lara-Lara F 2023. Use of ChatGPT at university as a tool for complex thinking: Students' perceived usefulness. *Journal of New Approaches in Educational Research*, 12(2):323–339. https://doi.org/10.7821/naer.2023.7.1458

Salem ABM 2000. The potential role of Artificial Intelligence technology in education. In *Proceedings of the International Conference on Technology in Mathematics Education*. Available at https://files.eric.ed.gov/fulltext/ED477318.pdf. Accessed 20 January 2024.

Salinas-Navarro DE, Vilalta-Perdomo E, Michel-Villarreal R & Montesinos L 2024. Using generative artificial intelligence tools to explain and enhance experiential learning for authentic assessment. *Education Sciences*, 14(1):83. https://doi.org/10.3390/educsci14010083

Scandura JM 2010. *The role of automation in education: Now and in the future*. Keynote address presented at the Annual Meeting of the American Educational Research Association, Denver, CO, 30 April - 4 May. Available at https://files.eric.ed.gov/fulltext/ED509936.pdf. Accessed 20 January 2024.

Shukla D 2018. eStyle - Artificial intelligence: Potential risks of artificial intelligence. *Electronics for You*, 1 September.

Slimi Z 2023. The impact of artificial intelligence on higher education: An empirical study. *European Journal of Educational Sciences*, 10(1):17–33. https://doi.org/10.19044/ejes.v10no1a17

So HJ, Jang H, Kim M & Choi J 2024. Exploring public perceptions of generative AI and education: Topic modelling of YouTube comments in Korea. *Asia Pacific Journal of Education*, 44(1):61–80. https://doi.org/10.1080/02188791.2023.2294699

Su J & Yang W 2023. Unlocking the power of ChatGPT: A framework for applying generative AI in education. *ECNU Review of Education*, 6(3):355–366. https://doi.org/10.1177/20965311231168423

Swindell A, Greeley L, Farag A & Verdone B 2024. Against artificial education: Towards an ethical framework for Generative Artificial Intelligence (AI) use in education. *Online Learning*, 28(2):7–27. https://doi.org/10.24059/olj.v28i2.4438

Tarin S & Yawiloeng R 2023. Learning to write through mind mapping techniques in an EFL writing classroom. *Theory and Practice in Language Studies*, 13(10):2490–2499. https://doi.org/10.17507/tpls.1310.07

Wach K, Duong CD, Ejdys J, Kazlauskaitė R, Korzynski P, Mazurek G, Paliszkiewicz J & Ziemba E 2023. The dark side of generative artificial intelligence: A critical analysis of controversies and risks of ChatGPT. *Entrepreneurial Business and Economics Review*, 11(2):7–30. https://doi.org/10.15678/EBER.2023.110201

Wang Y 2021. Artificial intelligence in educational leadership: A symbiotic role of human-artificial intelligence decision-making. *Journal of Educational Administration*, 59(3):256–270. https://doi.org/10.1108/JEA-10-2020-0216

Yan D, Fauss M, Hao J & Cui W 2023. Detection of AI-generated essays in writing assessments. *Psychological Test and Assessment Modeling*, 65(1):125–144. Available at https://www.psychologie-aktuell.com/fileadmin/Redaktion/Journale/ptam_2023-1/PTAM__1-2023_5_kor.pdf. Accessed 20 January 2024.

Yeo MA 2023. Academic integrity in the age of Artificial Intelligence (AI) authoring apps. *TESOL Journal*, 14(3):e176. https://doi.org/10.1002/tesj.716