

The Age of Artificial Intelligence and research in the educational landscapes of Brazil and Singapore

A Era da Inteligência Artificial e as pesquisas nos cenários educacionais do Brasil e de Singapura

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Abstract

Generative Artificial Intelligence (GAI) and algorithms have become increasingly present in our lives, impacting our social relationships, democratic life, and consequently, educational contexts. In this sense, this work presents an overview of how research on GAI, more specifically in the field of Letters/Languages, has developed in the Brazilian and Singaporean contexts. First, we point out how GAI has been incorporated into the Brazilian scenario in the field of Letters, mapping research collected from the virtual databases of the Coordination for the Improvement of Higher Education Personnel (CAPES) and the Scientific Electronic Library Online (SciELO). Second, we present contributions on how the use of GAI has occurred in the Singaporean context. Regarding the Brazilian context, the results indicate an effort in initial works with different perspectives and themes, but with gaps in the focus on the use of AI with students and the mobilization of discussions and results on Literacy, Language Education, Semiotics, Assessment, among other aspects. Regarding research in Singapore, AI in education is represented by the publications and projects from the National Institute of Education through the AI@NIE initiative. Themes emerging from this body of work point to a solid foundation, with opportunities to deepen impact through longitudinal research, broader disciplinary engagement, strengthened teacher professional learning, and further explorations into multimodal learning.

Keywords: Artificial Intelligence. Research. Language.

Resumo

A Inteligência Artificial Generativa (IAG) e os algoritmos têm estado cada vez mais presentes em nossas vidas, impactando nossas relações sociais, a vida democrática e, conseqüentemente, os contextos educacionais. Nesse sentido, este trabalho apresenta um panorama de como a pesquisa em IAG, mais especificamente na área de Letras/Línguas, tem se desenvolvido nos contextos brasileiro e de Singapura. Primeiramente, apontamos como a IAG tem sido incorporada ao cenário brasileiro da área de Letras, mapeando pesquisas coletadas nas bases de dados virtuais da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) e da Biblioteca Eletrônica Científica Online (SciELO). Em segundo lugar, apresentamos contribuições sobre como o uso da IAG tem ocorrido no contexto de Singapura. Em relação ao contexto brasileiro, os resultados indicam um esforço dos trabalhos iniciais com diferentes perspectivas e temáticas, mas com lacunas no enfoque no uso de IA com os alunos e na mobilização de discussões e resultados sobre Letramentos, Educação Linguística, Semiótica, Avaliação, dentre outros aspectos. Em relação à pesquisa em Singapura, a IA na educação está representada pelas publicações e projetos do Instituto Nacional de Educação por meio da iniciativa AI@NIE. Os temas que emergem desse conjunto de trabalhos apontam para uma base sólida, com oportunidades para aprofundar o impacto por meio de pesquisas longitudinais, maior engajamento disciplinar, fortalecimento da formação profissional de professores e novas explorações em aprendizagem multimodal.

Palavras-chave: Inteligência Artificial. Pesquisas. Linguagem.

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1 Introduction

We live in times when the popularization of the term Artificial Intelligence (hereinafter AI) has gained great prominence and unimaginable dimensions in society. Beyond this popularization, we know that it is omnipresent; according to Webb (2020, p. 1-2), “it is the technology upon which our future is being built, because it permeates all aspects of our lives: health and medicine, transport and housing, agriculture, sport, and even love, sex, and death”.

Virtually everything that reaches us is permeated by algorithms, from a simple search for information on platforms or applications to locate oneself spatially, to a parsimonious analysis of highly complex medical exams. We live and interact with algorithms more than we imagine; that is, we live with the effects of algorithms, since their performances are invisible. A good paraphrase, based on the words of Halliday (2004, p. 12), is that “there can be no social man without language”; therefore, in our times, there seems to be no social man without algorithms.

Given the omnipresence of AI in the most varied social spheres, it gives rise to different value judgments. In some spheres, there are salvationist visions of solutions to all problems, while in others, gloomy views and the end of human relationships predominate. In the educational sphere, there are those who understand new technologies as instruments of application and those who defend them as a metalanguage for processes of constructing meaning and social practices. In this perspective, an important part of the teaching-learning process in the age of Artificial Intelligence lies in the relational process. It resides in how we learn and teach how to ask the right questions to the systems and how to produce better prompts to obtain better answers from different AI technologies.

Thus, with tasks ranging from simple to complex, such as producing texts and videos, speaking, conversing, revising written texts, and other linguistic activities, these computer systems are gaining increasing acceptance and popularity. Consequently, they are being used by people from the most varied social segments, not always with critical or discursive awareness. Because of this, many debates have arisen in education regarding their impact on teaching, learning, teachers' work, issues involving authorship, creativity, the development of critical awareness, the dissemination of prejudices, mastery of technologies, understanding of the languages used, and possible multimodal transpositions.

From this perspective, this work focuses on Brazilian and Singaporean contexts. In the Brazilian scenario, we focus on research that has addressed AI in the fields of Literature/Languages and Arts and Multidisciplinary studies, seeking to understand how AI has been received and understood within the Brazilian context of language and multidisciplinary research. To this end, we initially aimed to map the research produced and accessible in the SciELO and CAPES databases for the short period of 2023 to 2025, in order to get a cartographic overview of the works that have been produced and how the topic has been approached. However, we do not intend to present a robust and concise state-of-the-art review. We will primarily reflect on the challenges facing research in the fields of Literature, Languages, and Multidisciplinary studies, particularly within universities. To this end, we sought to (i) investigate the productions (articles and dossiers) in these areas; and (ii) map the predominant thematic areas of the research in order to reveal the dominant approaches in the field, as well as to observe how perspectives of Multimodality, Semiotics, and Literacies are mobilized in these works.

Regarding research in Singapore, AI in education is represented through the publications and projects at the National Institute of Education (NIE), Nanyang Technological University. To identify themes and research gaps in the emerging field of AI in Education (AIEd) in Singapore for this paper, we analyzed the AI@NIE Resource List hosted on the LibGuides platform maintained by the NIE Library.

2 Overview of Research in Brazil

2.1 Data from SciELO

When observing the contributions of research on Artificial Intelligence in the context of Brazilian research, we see one recurring aspect in the problematization and discussion of its principles, history, and impact on the realization of many works. In this study, we chose to inventory a set of data from recent years (2023-2025), more specifically articles published in Portuguese, and took the initiative to propose a special issue in order to understand and answer our questions about what has been prob-

lematized and the recurring themes in the areas of Letters, Languages and Arts¹ and Multidisciplinary studies in Brazil.

The biggest challenge in mapping the studies was creating a rigorous database from the extracted data, considering the chosen platforms Scientific Electronic Library Online (SciELO)² and Portal CAPES³. No tool proved entirely efficient and reliable in identifying duplicate studies, or even studies already produced that did not appear in the database. Therefore, it was necessary to verify each publication individually, filtering and cross-referencing the results obtained from the search and storage platforms. Regarding the choice of the SciELO and CAPES platforms, they were selected because they constitute important sources of reference in scientific production, as they allow researchers open access to their publications, making them widely used in the academic community in Brazil. The table 1 summarizes the filters used.

Table 1. Selection and exclusion criteria.

Criterion number	Criterion	Description of the criterion
1	Search descriptors	Search using the term 'Artificial Intelligence'
2	Area	The review was restricted to articles in the fields of Literature/Languages and Arts and Multidisciplinary studies
3	Filter	Only articles with the 'Artificial Intelligence' filter were included
4	Publication Source	Only articles published in Brazilian scientific journals
5	Period	2023–2025
6	Language	Portuguese Language

Source: Elaborated by the authors.

When we inventoried the data on articles in the SciELO database using the criteria indicated in Table 1, we found only 30 publications. Despite the filters, we manually checked each publication and found one publication dated 2019, one from 2021, and another from 2022, which were ruled out. Regarding the language, even with the filter set to Portuguese, articles appeared in other languages with only the abstract in Portuguese, as summarized in the Figure 1.

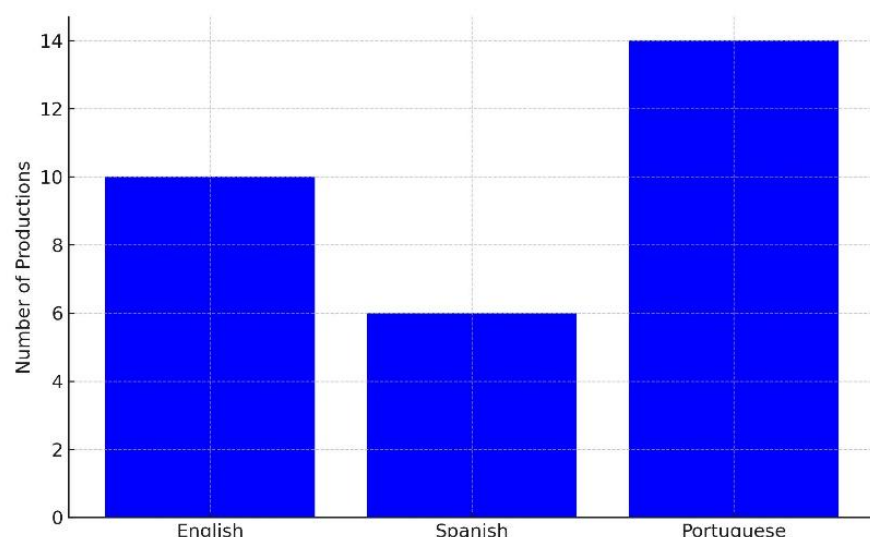


Figure 1. Mapping of productions by language.

Source: Elaborated by the authors.

¹ Research in the CAPES database is organized into broad areas. Thus, we have the Arts component as a broad area of language.

² <https://www.scielo.br/>

³ <https://www.periodicos.capes.gov.br/>

Regarding the productions found, the main topics addressed were: (a) Generative AI and Text Production & Creativity (4 texts); (b) AI in Education and Critical Literacy (6 texts); (c) AI and the Teaching of Additional Languages (5 texts); (d) AI and Translation: Training and Ethical Critique (7 texts); (e) AI and Human Sciences/Discourse & Media (5 texts). More specifically, regarding the productions related to topic (b) AI in Education and Critical Literacy, the articles emphasize the following in Table 2.

Table 2. Summary of article topics in SciELO.

Article	Focus
RUIZ MENDOZA, Karla Karina; PEDROZA ZÚÑIGA, Luis Horacio; LÓPEZ GARCÍA, Alma Yadhira. Creación y jueceo de ítems: ChatGPT como diseñador y juez. <i>Linguagem e Tecnologia</i> , v. 17, e51222, 2024. DOI: 10.1590/1983-3652.2024.51222.	Evaluating the effectiveness of ChatGPT 4.0 compared to human designers in creating and judging items for university entrance exams.
RODRIGUES, Olira Saraiva; RODRIGUES, Karoline Santos. A inteligência artificial na educação: os desafios do ChatGPT. <i>Texto Livre</i> , v. 16, e45997, 2023. DOI: 10.1590/1983-3652.2023.45997.	Study on the impacts of generative AI (ChatGPT) on higher education (plagiarism, critical development), proposing the enhancement of AI use from the perspective of augmented intelligence.
ROCHA, Lucio Agostinho. An evaluation of machine learning approaches in educational environments: a systematic literature review. <i>Linguagem e Tecnologia</i> , v. 18, e54910, 2025. DOI: 10.1590/1983-3652.2025.54910.	A systematic review on the application of machine learning-based methodologies in educational environments, highlighting challenges regarding the accuracy, reliability, and quality of information, and the need for legal and ethical considerations.
GIL QUINTANA, Javier; GARCÍA BLÁZQUEZ, Eduardo; HUESO ROMERO, José Javier; ROMERO RODRÍGUEZ, Luis Miguel. Redes comunicativas universitarias sNOOC por la educación mediática de la tercera edad. <i>Linguagem e Tecnologia</i> , v. 18, e53823, 2024. DOI: 10.1590/1983-3652.2025.53823.	Analysis of a Nano Open Online Massive (NOOC) communication network project to promote inclusive media literacy among the elderly population, integrating resources generated with AI and Metaverse.
BUZATO, Marcelo El Khouri; GONSALES, Priscila. Dimensões e enfoques alternativos para um modelo de letramentos críticos de inteligência artificial. <i>Revista Brasileira de Linguística Aplicada</i> , v. 25, n. 2, e44436, 2025. DOI: 10.1590/1984-6398202544436.	It proposes a multidimensional model of critical AI literacies based on a post-humanist approach (AI as cognitive assemblage) to support research agendas and educational policies in Brazil.
SACHETE, Andréia dos Santos; LOIOLA, Alba Valéria de Sant'Anna de Freitas; PEREIRA, Anderson Martins; ROSSI, Fábio Diniz; GOMES, Raquel Salcedo. EnemIA: correção de redações do Enem com Inteligência Artificial. <i>Linguagem e Tecnologia</i> , v. 18, e58426, 2025. DOI: 10.1590/1983-3652.2025.58426.	Introducing EnemIA, an AI tool to assist in grading Enem essays, offering detailed and personalized feedback, and evaluating its impact on the accuracy and speed of corrections.

Source: Elaborated by the authors.

These works indicate the challenges and understanding of the dimensions of AI use in the educational field and in language studies, with theoretical reflections. The productions related to topic (c), AI and Additional Language Teaching, emphasize the perceptions, beliefs, and acceptance of foreign language teachers regarding the use of AI; ethical concerns and the risk of redundancy in the teacher's work; and the need for teacher training, among others.

We highlight these two topics because they bring forward research more closely linked to issues of

language teaching and literacy. Despite a rich discussion of these aspects, few studies within these topics emphasize looking at the results of experiences with students in the teaching context, at the agency of the forms of interaction in the use of languages, and at the unfolding of the results of these experiences of use. The data indicate that we are still at the beginning of a long road in the integration of this technology into language teaching to think about new forms of literacy, agency, and learning.

2.2 Data from the CAPES Portal

Regarding the data inventoried from a search in the CAPES Portal database, using the filters described in Figure 2, we found the following results:

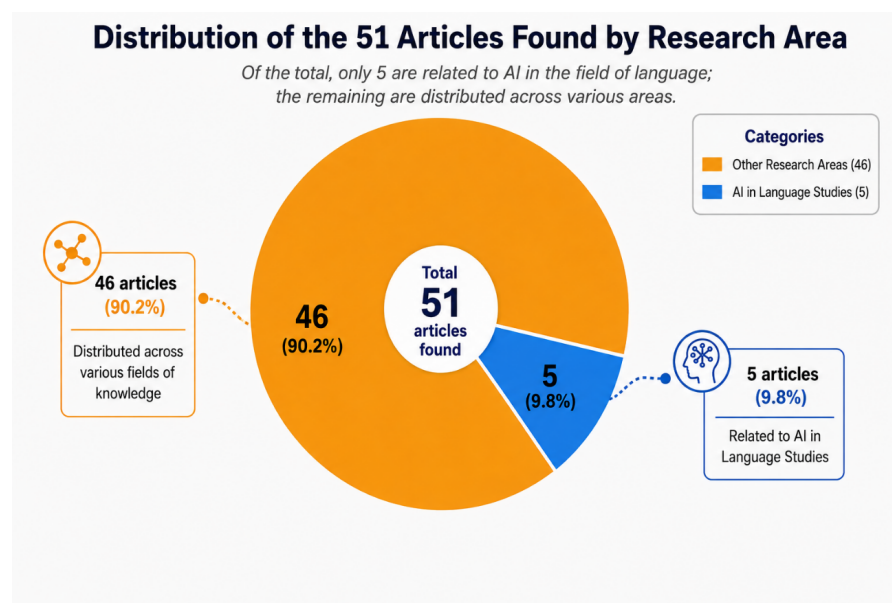


Figure 2. Survey of articles on the CAPES platform.

Source: Elaborated by the authors.

The data represented in Figure 2 indicate that of the 51 productions found, only 5 are related to the area of language; the others are articulated across various areas. Although we used the “Multidisciplinary” study area filter in the expectation of finding more works in the area of languages in dialogue with other areas, what was recurrent were works in diverse areas, with themes in health, environmental issues, engineering, education, agriculture, economics, among others.

2.3 Special issues in the Brazilian context

Given the challenges characteristic of the academic environment and the need to focus on the theme of AI in Brazilian research, especially in the area of languages, several researchers have organized special issues in recent years with a view to bringing together, disseminating, and strengthening research that has AI as a central point. Thus, we have mapped some dossiers produced in the national context, namely (Table 3).

A review of several special issues organized by our peers in the national context reveals an effort to bring together research that focuses on AI as a topic of discussion. Some of the works in these special issues appear in the SciELO and CAPES databases; however, with low frequency. We could list what each production in each special issue indicates, but that is not our focus at this moment. A careful reading of the productions, grouped by main themes, shows that they are articulated around the following themes:

1. AI, Interaction, Media, Disinformation, Racism, Ethics;
2. Literacy, Teaching, Digital Genres, Professional Training;
3. AI, Planning and Methodology of Language Teaching;
4. Translation, Digital Culture, Intermediality;

Table 3. Mapping of special issues in the Brazilian context.

Year	Special issues
2024	▪ <i>Linguagem em Foco</i> – v. 16, n. 2 (2024): <i>Multimodalidade e Tecnologia digital: desafios e impactos em tempos de IA para a pesquisa e ensino</i> Link: https://revistas.uece.br/index.php/linguagememfoco/issue/view/618 Results: 7 articles, 1 essay, 1 interview.
2025	▪ <i>Texto Livre Journal</i> – v. 18 (2025): <i>Linguagem e Tecnologia</i> Link: https://periodicos.ufmg.br/index.php/textolivre/issue/view/2344 Results: 18 articles about AI, 1 essay. ▪ <i>Revista de Estudos da Cultura (REVEC)</i> – v. 11, n. 27 (2025): <i>Inteligência Artificial</i> Link: https://periodicos.ufs.br/revec/issue/view/1407 Results: 18 articles. ▪ <i>Domínios da Linguagem</i> – v. 18, n. 1 (2024): <i>Algoritmos e sistemas de inteligência artificial e(m) processos de produção de sentidos</i> Link: https://seer.ufu.br/index.php/dominiosdelinguagem/issue/view/2389 Results: 11 articles. ▪ <i>Revista Texto Digital</i> – v. 21, n. 1 (2025): <i>Interfaces entre Linguística e Computação</i> Link: https://periodicos.ufsc.br/index.php/textodigital/issue/view/3937 Results: 9 articles. ▪ <i>Linguagem em Foco</i> – Dossiê Temático, v. 17, n. 3 (2025): <i>Inteligência Artificial, racismo algorítmico e outras exclusões</i> Link: https://revistas.uece.br/index.php/linguagememfoco Results: 15 articles. In addition to these special issues, others are being conducted for publication in 2026 with a thematic scope related to AI: – <i>Texto Livre Journal</i> – <i>Artificial intelligence and its interfaces with social life, language education, multimodality, and discourse</i> Link: https://periodicos.ufmg.br/index.php/textolivre/announcement – <i>Revista Linha D'Água</i> – Dossiê temático, v. 39, n. 2: <i>Repensando a educação linguística do Sul Global na era da Inteligência Artificial</i> Link: https://revistas.usp.br/linhadagua/announcement/view/1883

Source: Elaborated by the authors.

5. Critical View and Historical Trajectory of AI.

The works found in the special issues on the SciELO and CAPES platforms, besides revealing an important and challenging movement of initial work in the Brazilian context on AI with different perspectives and themes, reiterate one aspect: we still have little production or dissemination of research that focuses on the use of AI by students, especially in the area of language, and that mobilizes discussions and results on Literacies, Semiotics, Language Education, teaching-learning processes, AI and processes of evaluation and engagement, multimodal transpositions, among other topics.

In this way, this brief mapping of the Brazilian scenario points to the challenges we have as teachers and researchers and the paths we will need to take.

3 Overview of AI in Education Research in Singapore

3.1 National Institute of Education, Nanyang Technological University, Singapore

The National Institute of Education (NIE) at Nanyang Technological University (NTU) in Singapore is the country's sole national teacher education institute and serves as a cornerstone of Singapore's highly regarded education system. As an autonomous institute within NTU, one of the world's top young universities, NIE combines the advantages of a research-intensive technological university with deep, longstanding responsibilities to the nation's education ecosystem. It maintains a close, collaborative partnership with Singapore's Ministry of Education (MOE) and public schools, ensuring that teacher preparation remains tightly aligned with national education priorities and classroom realities.

In terms of AI research, NTU has been ranked first in the world in the 2025 Global Ranking of Academic Subjects (GRAS) published by ShanghaiRanking Consultancy⁴. NIE has also positioned itself as a leading hub for AI in Education (AIEd) research and practice in Singapore, particularly through its strategic AI@NIE initiative. Launched in 2022 as a five-year plan, AI@NIE represents NIE's deliberate, long-term commitment to harnessing Artificial Intelligence, including generative AI, machine learning, and learning analytics, to transform teaching, learning, assessment, and teacher preparation⁵.

As a way to identify the themes and research gaps from the initial work in the area of AIEd in Singapore for this paper, we examine the database in the AI@NIE Resource List, situated in the LibGuides maintained by the NIE Library. The site is publicly accessible at National Institute of Education (2026).

While clearly not intended to be exhaustive of the AI in Education work in Singapore, given that there are other organizations in Singapore engaging in AIEd work—for example, the AI Centre for Educational Technologies established by Singapore's MOE with the Smart Nation and Digital Government Office (SNDGO) at the National University of Singapore (NUS) School of Computing—the spotlight in this paper on NIE's AIEd work offers a quick snapshot of the forays into the exploration of AI for teaching and learning in Singapore rather than attempting to provide a comprehensive state of affairs.

3.2 AI@NIE Publications

As of January 2026, the AI@NIE site lists 143 journal articles from NIE researchers working in this area since 2019 (Appendix A). Notably, 122 (85%) of these journal articles were published since 2023, indicating a clear surge in research interest and output in AIEd since the release of ChatGPT and, with it, other publicly accessible GAI models in November 2022. The increase in recent years reflects a collective response to the recent technological advancements, such as large language models (LLMs) and GAI. Overall, the publications on AIEd center on five interconnected themes spanning GAI in pedagogy and assessment, human-AI collaboration, data-driven personalization, language and multimodal learning, and ethical and inclusive considerations.

GAI and LLM in Teaching, Learning, and Assessment

⁴ <https://www.shanghairanking.com/institution/nanyang-technological-university>

⁵ <https://www.ntu.edu.sg/nie/news-events/news/detail/the-nie-ntu-singapore-launches-ai@nie-to-transform-teaching-and-learning-for-21st-century-education>

This is the most prominent theme, encompassing the integration of tools such as ChatGPT, GPT-4V, and other generative models into educational processes. Publications explore applications ranging from personalized vocabulary learning and oral proficiency enhancement for young learners to automated item generation in STEM subjects, essay scoring, feedback provision, and multimodal assessment (e.g., visual question answering). A recurring topic is the tension between efficiency gains (scalability, immediacy of feedback) and pedagogical risks (over-reliance, erosion of critical thinking, authenticity of student work). Examples include studies on how interactions with GAI influence second-language speaking and summarization skills, as well as human–AI collaborative scoring comparisons. Publications also point to implications such as redefining teacher roles from content deliverers to designers of AI-augmented learning experiences and environments.

Human–AI Collaboration, Agency, and Hybrid Intelligence

A significant cluster of work emphasizes collaborative rather than substitutive relationships between humans (students, teachers, pre-service teachers) and AI systems. This includes teacher professional agency when using GAI knowledge-building companions, pre-service teachers' reflection and lesson planning supported by AI critiques or dashboards, and hybrid intelligence models that measure synergy in learning interactions. Many papers center on preserving human agency, ethical co-creation, and the augmentation of human capabilities (intelligence amplification) rather than replacement. Publications also offer implications for teacher education programs, suggesting a future where AI enhances rather than diminishes professional judgement and student autonomy by serving as a pedagogical aide for teachers and a learning companion for students.

Machine Learning for Prediction, Personalization, and Learning Analytics

This theme focuses on data-driven approaches that predict student outcomes, burnout, intervention responsiveness, cognitive load, or performance using machine learning models, often integrating physiological data (EEG, eye-tracking, wearables) or learning analytics dashboards. Applications span literacy and numeracy interventions, special educational needs, blended learning engagement, and even the identification of predictors of national reading achievement. A key topic is the increasing sophistication of combining multimodal data sources for more accurate predictions. Implications reported in the publications include the potential for proactive, equitable interventions in high-stakes systems, but also raise privacy, bias, and equity concerns when models are trained predominantly on local (e.g., Singapore) datasets.

AI in Language, Literacy, and Multimodal Learning

Language learning and literacy development, particularly in second-language (L2) and multilingual settings with AI, is another theme identified. Publications address AI-powered vocabulary tools, chatbot-assisted speaking/listening practice, GAI for literacy, digital multimodal composing, and automated written feedback in English and other languages (including Chinese). Papers investigated the role of AI in fostering agency, self-determination, and intercultural competencies, alongside risks of plagiarism and reduced authenticity, with some exploring the use of AI to support learners with dyslexia, aphasia, or special needs. This theme highlights Singapore's multilingual education landscape and positions AI as a powerful scaffold for linguistic diversity, with wider implications for global English-medium instruction contexts.

Ethical, Social, Psychological, and Inclusive Dimensions of AI Use

This final theme that emerged relates to broader societal and human consequences of AI adoption in education, including plagiarism risks, student reliance behaviors, critical thinking impacts, burnout moderation, mental health applications (e.g., AI as a “digital therapist”), and inclusive support for learners with disabilities. Publications frequently adopt cautionary tones, stressing the need for ethical frameworks, bias mitigation, equity considerations, and preservation of human values. The theme implies that technological enthusiasm must be tempered by rigorous ethical scrutiny and inclusive design, influencing both policy development and the framing of responsible AI integration in schools.

3.3 AI@NIE Research Projects

Twelve research projects on AIEd are listed on the AI@NIE site as of January 2026 (Appendix B). The projects are predominantly exploratory or proof-of-concept in nature, with a strong emphasis on

GAI, machine learning analytics, and human–AI interactions. As in the earlier analysis of the journal publications, the same five themes from the projects are discussed.

GAI and LLM in Teaching, Learning, and Assessment

This theme, mirroring the dominant publication cluster, centers on projects leveraging GAI to create educational tools, assessments, and personalized interactions. Examples include the “NIE x RI collab on generative AI for STEM assessment”, which evaluates LLMs for high-school STEM item generation, and “An Investigation on the Efficacy of Redesigning Learning Assessments with Gen AI”, which focuses on formative assessments with critiquing opportunities. The project “LLMs Chatbot Proof-of-Concepts” explores teaching from, with, about, and beyond AI and emphasizes the importance of the teacher’s role and pedagogy. Implications reinforce the publication theme’s call for ethical integration, suggesting NIE’s work could inform the development of scalable AI tools that can improve teaching, learning, and assessment in Singapore.

Human–AI Collaboration, Agency, and Hybrid Intelligence

This theme examines AI as a partner enhancing human agency, reflection, and interaction. Key projects include “TeacherGAIA”, a chatbot for student-centered learning in MOE schools, and “Does the Teacher Matter?”, which compares physiological responses to AI versus human teachers. These projects point to the importance of fostering teacher agency, as in AI-supported lesson critiques, and exploring hybrid models where AI augments rather than replaces humans. Implications extend the publication insights, advocating for designs that preserve human judgment, with broader potential to reshape pre-service teacher training.

Machine Learning for Prediction, Personalization, and Learning Analytics

This theme speaks to a data-driven focus in the projects, using Machine Learning to predict behaviors, personalize learning, and analyze multimodal data. Projects like “AI-Empowered Analytics on Gesture” and “AI-Empowered Analytics on Joint Attention” employ models (e.g., MediaPipe, YOLOv7) to track bodily engagement and gaze in collaborative settings. “Open emotion learner modeling” refines emotional predictions via human feedback. These projects emphasize proactive interventions and highlight the need for more representative and robust datasets to avoid biases in diverse learner populations.

AI in Language, Literacy, and Multimodal Learning

This theme focuses on the use of AI for literacy and multimodal learning, particularly for young or multilingual learners. “ARCHE 2.0” exemplifies an AI-powered seamless Chinese vocabulary system, while multimodal learning features in the other projects, “AI-Empowered Analytics on Gesture” and “AI-Empowered Analytics on Joint Attention”.

Ethical, Social, Psychological, and Inclusive Dimensions of AI Use

The final theme relates to AI’s impacts on inclusion, emotions, and well-being. Projects such as “AARA-DA” (VR avatar for dyscalculia remediation) and “Students’ AI-Augmented Thinking” probe AI-augmented cognition and emotions. “Embodied Learning Companions” evokes trust through realistic avatars. The projects point to the need for ethical frameworks to ensure AI promotes equity and metacognition in inclusive settings.

3.4 Research Gap and Implications

Reflecting on the snapshot of publications and research projects on AIEd from NIE in Singapore, there are discernible implications and opportunities for further research that can inform strategic priorities in this area. At present, long-term longitudinal studies, disciplinary breadth beyond language/STEM, teacher readiness/adoption barriers, and integration with emerging multimodal technologies remain relatively underexplored.

Long-term Impact and Longitudinal Studies

Despite a growing body of short-term efficacy studies, perception surveys, and proof-of-concept evaluations, there is a paucity of longitudinal research examining the sustained impact of AI interventions on learning and teaching over time. Most studies capture immediate or short-cycle outcomes, such as shifts in learner perceptions following ChatGPT use or short-term gains associated with AI-supported tasks, leaving open critical questions about durability and transfer. In particular, there is

limited evidence on whether early AI scaffolding supports the development of independent, critical, and ethical thinking, or whether patterns of over-reliance and surface engagement emerge over extended periods. Similarly, many projects prioritize short-term indicators, such as emotional arousal or immediate tool effectiveness, without tracing how AI-mediated practices shape learner dispositions, academic integrity, or teacher identity across multiple years. Addressing this gap would be helpful for understanding the use of AI in education as a sustained pedagogical presence.

Subject and Disciplinary Breadth Beyond Language and STEM

Current AIED research at NIE exhibits a strong concentration in language education and STEM-related domains, with comparatively limited attention to the humanities, social sciences, arts, vocational and technical education, physical education, or values and character education. While this focus is understandable, it may narrow conceptions of where and how AI can meaningfully contribute to learning. Both publications and projects tend to foreground discrete skills (e.g., vocabulary acquisition or mathematical reasoning), with fewer studies exploring AI's potential in interpretive, creative, ethical, or culturally situated forms of learning. Expanding disciplinary coverage would enable broader accounts of how AI can support learning in a range of subject domains.

Teacher Professional Learning, Readiness, and Adoption Barriers

Although several studies acknowledge the crucial role of teachers in AI integration, systematic investigation into in-service teachers' professional learning trajectories, readiness levels, and adoption challenges remains limited. Existing publications largely prioritize student-facing applications, while projects that develop teacher-oriented tools tend to focus on functionality rather than the organizational, workload, and identity-related implications of sustained use. Issues such as resistance, professional trust in AI systems, time constraints, and alignment with school-level structures are seldom examined in depth. There is therefore a need for research that positions teachers not simply as users of AI tools, but as designers of learning whose professional judgment, values, and working conditions fundamentally shape the impact of AIED.

Integration with Emerging Technologies and Multimodal Learning

Finally, there is limited empirical exploration of how AI intersects with other emerging educational technologies, including extended reality, robotics, blockchain-based credentialing, or advanced immersive and embodied environments. As education moves towards increasingly multimodal and hybrid learning ecologies, deeper theorization and design-based research will be needed to examine how AI participates in complex assemblages of modes, media, and technologies.

Notwithstanding the gaps surfaced, the current body of AIED research at NIE demonstrates the institute's interest and commitment to understanding the use and effect of new and emerging technologies for teaching, learning, and assessment. At the same time, the relative underexploration of long-term longitudinal effects, disciplinary diversity beyond language and STEM, teacher professional readiness and adoption barriers, and deep integration with emerging multimodal and immersive technologies offers uncharted waters for further exploration.

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Data availability

Research data is available in the body of the document.

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A Appendix A – Articles from NIE researchers

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B Appendix B – Projects on AIEd

Project Name	Project Developer/ PI	Project Description
NIE x RI collab on generative AI for STEM assessment	Ast/P Farhan Ali Ast/P Joonhyeong Park Mr Kuang-Wen Chan	This project comprehensively assesses large language models for their capabilities in generating advanced high school assessment items in various STEM subjects.
TeacherGAIA	Ast/P Farhan Ali	TeacherGAIA is a generative-AI chatbot developed by LSA to support diverse forms of student-centered learning. It is currently in use in numerous MOE schools with free accounts for teachers and students.
AI-Empowered Analytics on Gesture	A/P Chen Wenli Ms Lyu Qianru	This research explores how students apply bodily engagement for computer-supported collaborative learning (CSCL). We have utilized MediaPipe, a machine learning model, to analyze video files and extract moment-by-moment body landmarks. This approach allows us to understand and visualize how students use hand movements and body gestures during collaborative learning activities.
AI-Empowered Analytics on Joint Attention	A/P Chen Wenli Ms Lyu Qianru	This research examines how students apply joint attention, specifically synchronized gazing detection, for collaborative learning. By using machine learning models such as YOLOv7 for gazing detection and object detection, we analyze video files to capture moment-by-moment gazing and object detection. This method provides a precision level of 60% to 89%.
LLMs Chatbot Proof-of-Concepts	A/P Tan Seng Chee Ms Tan Yee Yin	Six different proof-of-concepts chatbots that explore and exemplify teaching and learning from, with, about, and beyond AI.
ARCHE 2.0	Ast/P Wen Yun	An AI-powered seamless Chinese vocabulary learning system for young learners.
Students' AI-Augmented Thinking, Academic Performance and Emotions During Problem Solving	Ast/P Zhu Gaoxia	This project aims to understand students' thinking processes when programming with the support of generative AI or not; and examine what factors will impact AI-augmented thinking.
Embodied Learning Companions as an Experimentation Platform for Scaffolding in the Learning Sciences	Ast/P Tanmay Sinha	Learning companions, implemented as 2-D/3-D virtual characters, can evoke trust with human-like shape and form (appearance realism) and provide multimodal adaptive support based on inferred multimodal student behaviors (behavior realism).

Table 4 (continued)

Project Name	Project Developer/ PI	Project Description
AARA-DA: AI-Powered Avatar, Adaptive Progression and Remediation Analytics for Dyscalculia	Ast/P Azilawati Jamaludin Dr Lim Choon Guan	AARA-DA is a neuroscience-informed mathematics Fractions games powered by a VR teacher/caregiver avatar that is trained to provide personalized cognitive and affective care for learners between the ages of 7 and 13.
An Investigation on the Efficacy of Redesigning Learning Assessments with Gen AI	Dr. Kumaran Rajaram Ast/P Tanmay Sinha	The project aims to develop innovative formative assessments that use GenAI to provide deliberate critiquing opportunities for students and assess their impact on learning across interdisciplinary courses at NBS and NIE.
Does the Teacher Matter? University Students' Physiological Responses in Online Interactions with an AI-Chatbot and a Human Teacher	Ast/P Victor Lim Fei	The study aims to explore how students respond to the use of generative AI by examining potential differences in students' levels of interest, measured through emotional arousal, when communicating with an AI bot versus a human to learn about a new topic. The findings will inform effective AI integration in educational settings to enhance learning outcomes.
Open emotion learner modeling to improve machine predictions and improve human metacognition	Ast/P Tanmay Sinha Ast/P Toh Wei Xing Dr. Elizabeth Koh	The project aims to kill two birds with one stone—improve emotionally aware AI as well as students' self-regulated learning—by creating open learner models (OLMs) where emotional predictions can be refined with human feedback. Different interaction designs for OLMs to enhance emotional awareness and regulation in education will be tested.

Source: Elaborated by the authors.