



**FEDERAL UNIVERSITY OF SERGIPE
OFFICE OF THE DEAN OF GRADUATE STUDIES AND RESEARCH
GRADUATE PROGRAM IN EDUCATION
PhD IN EDUCATION**

ALLESSANDRA ELISABETH DOS SANTOS

GENERATIVE ARTIFICIAL INTELLIGENCE AND ITS IMPACT ON WRITING

**SÃO CRISTÓVÃO-SE-BRAZIL
2024**

ALLESSANDRA ELISABETH DOS SANTOS

GENERATIVE ARTIFICIAL INTELLIGENCE AND ITS IMPACT ON WRITING

Doctoral dissertation presented to the Graduate Program in Education (PPGED) as a requirement serving the application phase for the Ph.D. in Education at the Federal University of Sergipe.

Area: Education

Field of study: Technologies, Languages, and Education

Advisor: Prof. Dr. Paulo Roberto Boa Sorte Silva

Co-advisor: Prof. Dr. Neiva da Silva Rego Ravagnoli

SÃO CRISTÓVÃO-SE-BRAZIL

2024

**FICHA CATALOGRÁFICA ELABORADA PELA BIBLIOTECA CENTRAL
UNIVERSIDADE FEDERAL DE SERGIPE**

S237g Santos, Allessandra Elisabeth dos
Generative Artificial Intelligence and its impact on writing /
Allessandra Elisabeth dos Santos ; advisor Paulo Roberto Boa
Sorte Silva. – São Cristóvão, SE, 2024.
156 f. : il

Thesis (doctorate in Education) – Federal University of Sergipe,
2024.

1. Education. 2. Artificial intelligence – Effect of [...] on. 3.
Language and education. 4. ChatGPT. 5. Writing. I. Silva, Paulo
Roberto Boa Sorte, advisor. II. Title.

CDU 37:004.8:81



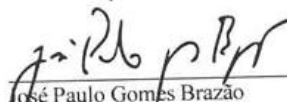
UNIVERSIDADE FEDERAL DE SERGIPE
PRÓ-REITORIA DE PÓS-GRADUAÇÃO E PESQUISA
PROGRAMA DE PÓS-GRADUAÇÃO EM EDUCAÇÃO

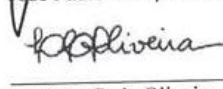


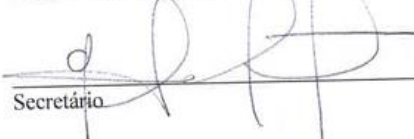
ATA DA REUNIÃO DA COMISSÃO JULGADORA DA TESE DE DOUTORADO
APRESENTADA POR ALLESSANDRA ELISABETH DOS SANTOS PARA OBTENÇÃO
DO TÍTULO DE DOUTORA EM EDUCAÇÃO.

Aos vinte e três dias do mês de agosto do ano dois mil e vinte e quatro, às dez horas, na modalidade on-line, pelo Programa de Pós-graduação em Educação, reuniu-se a Comissão Julgadora da Tese em epígrafe, indicada pela Coordenação do Programa de Pós-Graduação em Educação da Universidade Federal de Sergipe, com parecer favorável do Colegiado. A banca foi composta pelos professores doutores Paulo Roberto Boa Sorte Silva (orientador), Simone de Lucena Ferreira e José Paulo Gomes Brazão da Universidade Federal de Sergipe; Neiva Cristina da Silva Rego Ravagnoli do US Army, Luciana C. de Oliveira da VCU e David Kohan Marzagao do King's College, para examinar o trabalho de Alessandra Elisabeth dos Santos, apresentado sob o título *"Generative Artificial Intelligence and its Impact on Writing"*. O orientador, assumindo os trabalhos na qualidade de Presidente, passou a palavra à candidata para que ela expusesse sua Tese, informando que a mesma dispunha de vinte minutos para a apresentação; cada examinador dispunha de trinta minutos e a candidata de mais trinta minutos para respostas. Terminada a exposição da doutoranda, o Presidente passou a palavra aos membros da Comissão Julgadora, que iniciaram a arguição na seguinte ordem: Prof. Dr. David Kohan Marzagao; Prof.^a Dr.^a Luciana C. de Oliveira; Prof.^a Dr.^a Neiva Cristina da Silva Rego Ravagnoli; Prof. Dr. José Paulo Gomes Brazão; Prof.^a Dr.^a Simone de Lucena Ferreira e o Prof. Dr. Paulo Roberto Boa Sorte Silva. Terminada a arguição, foi dada a palavra à candidata para que ela, se desejasse, fizesse as observações finais. Os membros da Comissão Julgadora se retiraram da sala para deliberarem. Voltando logo em seguida, o Presidente anunciou que a candidata foi considerada **APROVADA**. O Presidente proclamou a candidata **"Doutora em Educação"**, devendo este resultado ser homologado pela comissão da Coordenação de Pós-Graduação. Em seguida, agradeceu aos membros da Comissão Julgadora. Nada mais havendo a tratar, o Presidente encerrou esta sessão, cujos trabalhos são objetos desta ata, lavrada por mim, Guilherme Barbosa Biriba, secretário do Programa, da qual assino juntamente com os membros da Comissão Julgadora. Cidade Universitária "Prof. José Aloísio de Campos", 23 de agosto de 2024.


Paulo Roberto Boa Sorte Silva


José Paulo Gomes Brazão

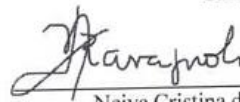

Luciana C. de Oliveira

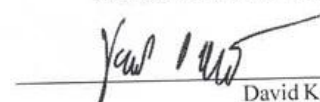

Secretário

gov.br

Documento assinado digitalmente
SIMONE DE LUCENA FERREIRA
Data: 06/09/2024 09:41:30-0300
Verifique em <https://validar.iti.gov.br>

Simone de Lucena Ferreira


Neiva Cristina da Silva Rego Ravagnoli


David Kohan Marzagao

*In loving memory of Dinda Marisa,
Vovó Carmosa,
and my sweet Paris,
whose spirit and love continue to inspire me.*

SPECIAL ACKNOWLEDGMENTS

To my esteemed advisor, Prof. Dr. Paulo Boa Sorte Silva, thank you for the countless lessons and the unwavering support throughout my research journey. Your belief in my abilities, even before I could see them myself, has been the true hallmark of your role as an educator. This trust has been instrumental in shaping my path as a researcher. You embody more than a mentorship role; you are a profound source of inspiration and knowledge, bridging both academic and personal spheres. My deepest appreciation and respect are forever yours.

SPECIAL ACKNOWLEDGMENTS

I am immensely grateful for the guidance and support of my co-advisor, Prof. Dr. Neiva Cristina da Silva Rego Ravagnoli, a knowledgeable researcher in Complex Thinking, who has skillfully guided me along the learning path of this epistemology. Your gentle, friendly, and humorous approach has always made me feel welcomed, greatly aiding my learning process. It has been a privilege to have you shape my formation as a researcher, starting from my Master's degree and continuing through my doctoral journey. My deepest appreciation and respect are forever yours.

ACKNOWLEDGMENTS

I extend my sincere gratitude to Prof. Dr. Luciana C. de Oliveira, my PDSE Supervisor from Virginia Commonwealth University (VCU), for her instrumental role in my development as a researcher. Her willingness to integrate me into collaborative writing projects with members of her research group has opened numerous doors and provided me with an enriching learning experience. I cannot thank her enough for the opportunities to co-write with her and her team, which have greatly enhanced my understanding and skills. Her support and mentorship have been invaluable, and for this, I am profoundly thankful.

I am deeply grateful to Prof. Dr. Simone de Lucena Ferreira for her valuable contributions to my dissertation at every stage. I also thank her for her constant presence and unwavering support throughout my academic journey, starting from my master's degree. Her guidance has enhanced my work and has been crucial in shaping my development as a researcher.

I am deeply appreciative of Prof. Dr. David Kohan Margazao for his significant role during my qualifying exam. His thought-provoking questions and challenges have not only deepened my understanding but also encouraged me to pursue a more insightful research path. His support has been instrumental in my academic growth, and I am immensely grateful for his guidance.

I am profoundly thankful to Prof. Dr. José Paulo Gomes Brazão for his insightful contributions during my qualifying exam. The questions and challenges he presented were crucial in guiding me toward a more fulfilling research journey. His guidance has been indispensable in defining the direction of my work. Additionally, his expert feedback has greatly enriched my research, enhancing both its depth and clarity.

I am also grateful to the friends I have made during this journey, especially my roommates Chardé Reid and Lily, who made my stay in Richmond a memorable experience, and Ben Olsoe, who welcomed me during my PhD Sandwich Program at VCU and who became a valued friend. Thank you for your support and friendship.

I would like to acknowledge the friends with whom I collaborated on writing projects: Larisa Olesova, Cristiane Vicentini, Karen Terrell, Jia Gui, Tara Willging, Joy Beatty, and Destini Braxton. Their insights and teamwork were instrumental in enhancing the quality of my writing.

In addition, I want to extend my gratitude to the members of the TECLA research group, whose contributions during our meetings significantly improved my research. Their collective

expertise and collaborative approach played a significant role in refining my research and advancing this dissertation.

Special thanks to my dear friend/sister, Laila Gardênia, for her exceptional technical assistance in refining the layout of my Prompt Creation Reference Chart and some images in my dissertation, as well as for her emotional support throughout this challenging journey. I also extend my gratitude to Nadege Siqueira, Bruna Oliveira, and Jefferson Santos for their dedicated and constant support.

I would like to extend my heartfelt gratitude to all my beloved family members, especially my parents, Adalberto Antônio dos Santos and Josefa Nelma dos Santos, for the love and dedication they have provided me throughout my years of study. I am also deeply thankful to my uncle, who has been a father figure, João Batista dos Santos, and to my youngest brother, Allisson Mário dos Santos, for their encouragement and loving presence in my life.

I wish to thank my partner, Mirco Buiano, for his support and dedication over these four years. Despite the challenges of living in different countries, his companionship and encouragement throughout my writing process have been invaluable. His love and commitment have been essential in helping me navigate this challenging journey.

Finally, I would like to thank the Coordination for the Improvement of Higher Education Personnel (CAPES) for the financial support provided through the scholarship, which was essential for the development of this research.

ABSTRACT

AI: word of 2023. The abbreviation of Artificial Intelligence (AI) was named the word of the year by Collins Dictionary, reflecting its growing prominence in everyday life. Although AI has long permeated various aspects of human activity, our society only began recognizing its ubiquitous presence after ChatGPT was released on November 30, 2022. ChatGPT, an AI chatbot that produces human-like responses, exemplifies Generative Artificial Intelligence (GenAI) technologies now widely accessible, provoking discussions and raising ethical concerns across social, political, economic, and academic contexts. In education, technologies undeniably reshaped writing, a social practice grounded in evolving literacy perspectives. Recognizing these transformations, the central question of this study is: How does the integration of GenAI technologies, like Large Language Models (LLMs), redefine the concept of writing in educational contexts? To address this question, this research aims to apprehend the concept of the phenomenon of writing impacted by the adoption of GenAI in societal contexts in the field of education. Additionally, the specific objectives are to examine the approach to writing conveyed on internet-based platforms, particularly after the launch of ChatGPT, and to explore educational, pedagogical, and ethical issues related to the impact of AI-text generators, especially ChatGPT, raised on these platforms. Considering that the study of the phenomenon of writing cannot be done in isolation from our society, knowledge, and culture, it is crucial to adopt an epistemological and methodological approach that rejects oversimplifying realities. Guided by Complex Thinking (Morin, 2015), this qualitative, documentary, and bibliographic study analyzed 60 documents — including digital newspaper articles, social media posts, YouTube videos, podcasts, and websites — using Analytical Entwinings integrated with GenAI. Findings revealed eight theoretical constructs. The key terms — revolution, integrity, and transformation — were extracted from the first three constructs and address the first specific objective of this research. While the key terms — enhancement, support, quality, authenticity, equity, and integration — extracted from five theoretical constructs, address the second objective. By situating writing as an evolving social practice that interacts reciprocally with GenAI, the study suggests that GenAI broadens writing as a social technology, reinforcing the need for adaptive strategies that ensure AI augments rather than replaces human agency. The integration of GenAI in writing, analyzed through the principles of Complex Thinking, reveals a complex interplay between technology and human agency, with both elements in constant adaptation, influencing each other systemically, holographically, recursively, and dialogically, ensuring that the writing process remains dynamic and grounded

in humanistic values. Recognizing writing as part of this evolving system, this research introduces the concept of writing as an ecosystem, in which technology and human elements are interdependent and mutually enhancing, contributing to a more collaborative and adaptive approach to writing instruction.

Keywords: generative artificial intelligence; large language models; ChatGPT; education; writing.

RESUMO

IA: palavra de 2023. A abreviatura de Inteligência Artificial (IA) foi nomeada a palavra do ano pelo Dicionário Collins, refletindo sua crescente proeminência na vida cotidiana. Embora a IA já permeasse vários aspectos da atividade humana, nossa sociedade apenas passou a reconhecer a sua presença ubíqua após o lançamento do ChatGPT, em 30 de novembro de 2022. O ChatGPT, um chatbot de IA que gera respostas semelhantes às de humanos, exemplifica as tecnologias de Inteligência Artificial Generativa (IAG) atualmente amplamente acessíveis, provocando discussões e suscitando preocupações éticas em contextos sociais, políticos, econômicos e acadêmicos. No campo da educação, as tecnologias inegavelmente remodelaram a escrita, entendida como uma prática social fundamentada em perspectivas de letramentos em constante evolução. Reconhecendo essas transformações, a questão central deste estudo é: Como a integração de tecnologias de IAG, como Modelos de Linguagem de Grande Escala (LLMs), redefine a concepção de escrita em contextos educacionais? Para responder a essa pergunta, esta pesquisa objetiva apreender a concepção do fenômeno escrita impactado pela adoção da IAG em contextos sociais na área da educação. Além disso, propõe-se como objetivos específicos examinar a abordagem da escrita veiculada em plataformas digitais, sobretudo após o lançamento do ChatGPT, e explorar questões educacionais, pedagógicas e éticas relacionadas ao impacto de geradores de texto em IA — especialmente o ChatGPT — levantadas nessas plataformas. Considerando que o estudo do fenômeno escrita não pode se dissociar de nossa sociedade, conhecimento e cultura, torna-se fundamental adotar uma perspectiva epistemológica e metodológica que rejeite a simplificação excessiva das realidades. Orientado pelo Pensamento Complexo (Morin, 2015), este estudo qualitativo, de caráter documental e bibliográfico, analisou 60 documentos — incluindo artigos de jornais digitais, publicações em redes sociais, vídeos no YouTube, podcasts e sites — utilizando o Entrelace Analítico integrado à IAG. Os resultados evidenciaram oito construtos teóricos. Os termos-chave — revolução, integridade e transformação — foram extraídos dos três primeiros construtos e atendem ao primeiro objetivo específico desta pesquisa. Já os termos-chave — aprimoramento, suporte, qualidade, autenticidade, equidade e integração — extraídos de cinco construtos teóricos, respondem ao segundo objetivo. Ao situar a escrita como uma prática social em constante evolução e em interação recíproca com a IAG, o estudo sugere que a IAG amplia a escrita como tecnologia social, reforçando a necessidade de estratégias adaptativas que garantam a complementação, em vez da substituição, da agência humana. A integração da IAG à escrita, analisada sob os princípios do Pensamento Complexo, revela uma interação complexa

entre tecnologia e agência humana, com ambos os elementos em contínua adaptação, influenciando-se mutuamente de maneira sistêmica, holográfica, recursiva e dialógica. Isso assegura que o processo de escrita permaneça dinâmico e ancorado em valores humanísticos. Reconhecendo a escrita como parte desse sistema em evolução, esta pesquisa introduz a concepção de escrita como ecossistema, em que aspectos tecnológicos e humanos são interdependentes e se fortalecem mutuamente, contribuindo para uma abordagem de ensino da escrita mais colaborativa e adaptativa.

Palavras-chave: inteligência artificial generativa; modelos de linguagem de grande escala; ChatGPT; educação; escrita.

LIST OF FIGURES

Figure 1 – How worried should you be about AI disrupting elections?	22
Figure 2 – ChatGPT and the 2024 US election	23
Figure 3 – Imagined arrest images of Donald Trump created using Midjourney v5	24
Figure 4 – ChatGPT: 1 million active users	25
Figure 5 – Article: What is in store with the GPT-3 algorithm?	27
Figure 6 – First published article generated by GPT-3 large language model	27
Figure 7 – ChatGPT is banned in Italy	28
Figure 8 – ChatGPT is banned in NYC public schools	29
Figure 9 – Teachers’ reactions towards ChatGPT	30
Figure 10 – Research concept map	36
Figure 11 – Scientific publications and presentations	39
Figure 12 – My research in light of Complex Thinking	47
Figure 13 – Complex Thinking: research guiding questions	49
Figure 14 – GPT-3 in journalism	50
Figure 15 – AI: <i>Fantástico</i> News report	50
Figure 16 – AI text generator selection criteria	52
Figure 17 – Complex Thinking: my research guiding questions	54
Figure 18 – My guiding questions	55
Figure 19 – Designing my path	56
Figure 20 – Analytical Entwining	59
Figure 21 – ChatGPT: 100 million active users	61
Figure 22 – Analytical Entwining Integrated with GenAI	66
Figure 23 – Prompt Creation Reference Chart 1	67
Figure 24 – Prompt Creation Reference Chart 2	69
Figure 25 – Prompt Creation Reference Chart 3	73
Figure 26 – Prompt Creation Reference Chart 4	77
Figure 27 – The Journey of OpenAI GPT Models	81
Figure 28 – Methodological Path	83
Figure 29 – Theoretical Constructs: specific objective 1	87
Figure 30 – “Screenshot of the reality I see” 4C	90
Figure 31 – “Screenshot of the reality I see” 3B	91
Figure 32 – “Screenshot of the reality I see” 5B	94

Figure 33 – “Screenshot of the reality I see” 3C	96
Figure 34 – “Screenshot of the reality I see” 5A	98
Figure 35 – “Screenshot of the reality I see” 5B	103
Figure 36 – Theoretical Constructs: specific objective 2	107
Figure 37 – “Screenshot of the reality I see” 1E	110
Figure 38 – “Screenshot of the reality I see” 2E	112
Figure 39 – “Screenshot of the reality I see” 3E	114
Figure 40 – “Screenshot of the reality I see” 1D	117
Figure 41 – “Screenshot of the reality I see” 4D	119
Figure 42 – “Screenshot of the reality I see” 4F	122
Figure 43 – “Screenshot of the reality I see” 5F	126
Figure 44 – “Screenshot of the reality I see” 4D	130
Figure 45 – “Screenshot of the reality I see” 4E	132
Figure 46 – My research journey	137
Figure 47 – The concept of writing impacted by GenAI	138

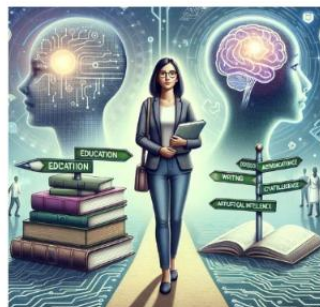
LIST OF TABLES

Table 1 – Data: digital newspaper articles.....	62
Table 2 – Repeated ideas: initial theme	62
Table 3 – Repeated ideas: second theme	63
Table 4 – Theoretical constructs and themes.....	64
Table 5 – Visualizing Prompt No. 1	68
Table 6 – Visualizing Prompt No. 2	70
Table 7 – Visualizing Output Text Document 4C	71
Table 8 – Visualizing Prompt No. 3	74
Table 9 – Visualizing Output - Prompt No. 3 - Specific Objective 1.....	75
Table 10 – Visualizing Prompt No. 4.....	78
Table 11 – Visualizing Output - Prompt No. 4 - Specific Objective 1.....	78

LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AWE	Automated Writing Evaluation
CAPES	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior
CEP	Comitê de Ética em Pesquisa
CESAD	Centro de Educação Superior a Distância
DL	Deep Learning
GenAI	Generative Artificial Intelligence
GLTR	Generative Textual Likelihood Ratio
GPT	Generative Pre-trained Transformer
ICC	International Criminal Court
IOA	Intelligent Online Assessment
IoT	Internet of Things
LLMs	Large Language Models
ML	Machine Learning
NLP	Natural Language Processing
PMFGN	Personalized Multimodal Feedback Generation Network
PDSE	Programa de Doutorado Sanduíche no Exterior
PPGED	Programa de Pós-Graduação em Educação
TCLE	Termo de Consentimento Livre e Esclarecido
TECLA	Tecnologias, Educação e Linguística Aplicada
TLMs	Transformer Language Models
UFS	Universidade Federal de Sergipe
UFSC	Universidade Federal de Santa Catarina
UNCISAL	Universidade Estadual de Ciências da Saúde de Alagoas
UNINASSAU	Centro Universitário Maurício de Nassau
VCU	Virginia Commonwealth University

TABLE OF CONTENTS



The beginning of my journey 19



Methodological path 43



**Approaches to writing
in education with
Generative AI** 86



**Educational, pedagogical,
and ethical issues of
AI text generators** 106

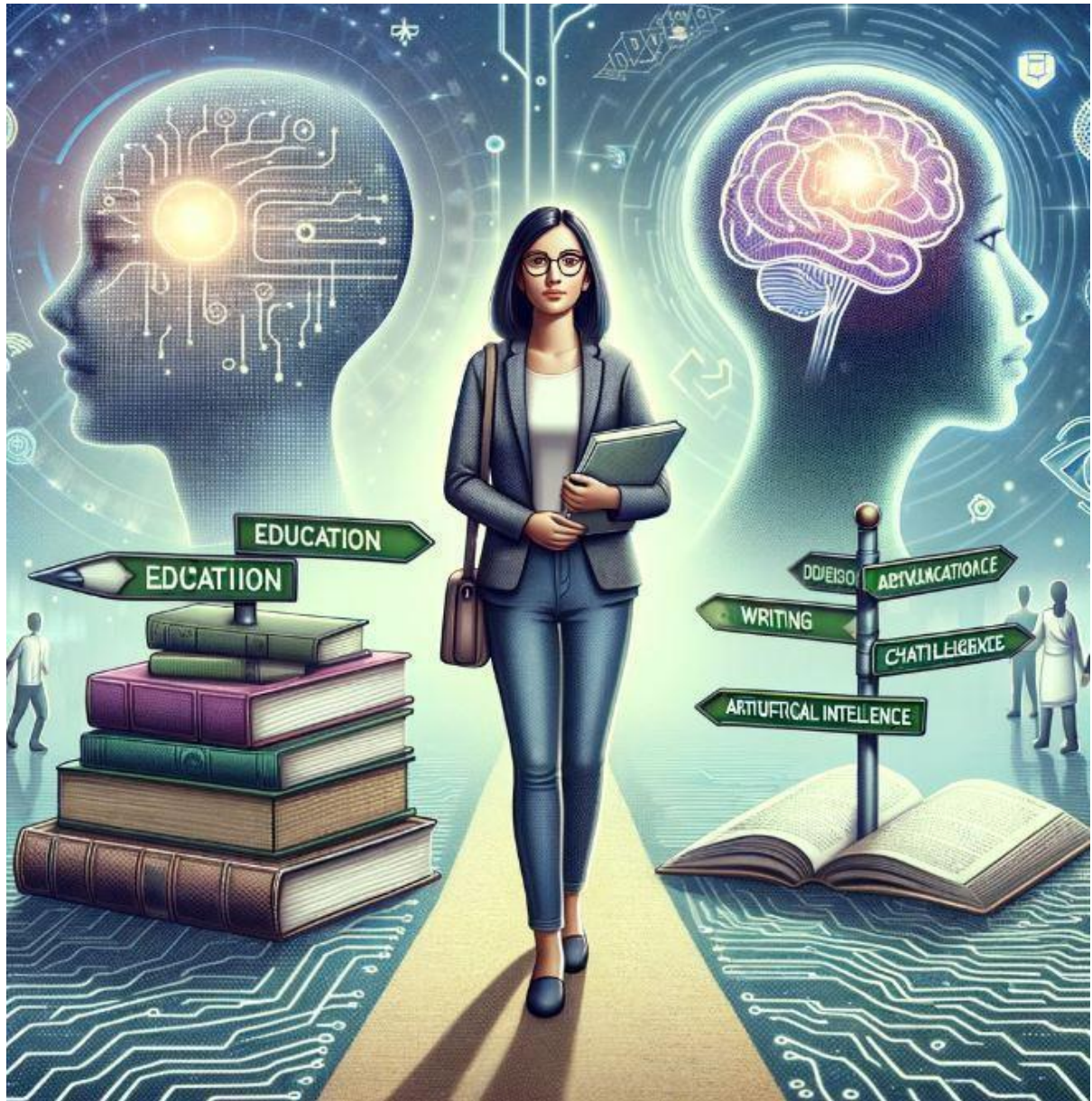


Final remarks 136

TABLE OF CONTENTS

1	THE BEGINNING OF MY JOURNEY	19
2	METHODOLOGICAL PATH.....	43
2.1	Complex Thinking and its core principles	44
2.2	The nature of research	48
2.3	The change of course	49
2.4	Redesigning my path	53
2.5	Method of analysis.....	57
3	APPROACHES TO WRITING IN EDUCATION WITH GENERATIVE AI.....	86
3.1	Writing is revolutionized by AI through enhancement and accessibility	88
3.2	Writing integrity is maintained through AI-driven ethical safeguards	95
3.3	Writing education is transformed by AI through personalization and global reach.....	101
4	EDUCATIONAL, PEDAGOGICAL, AND ETHICAL ISSUES OF AI TEXT GENERATORS	106
4.1	Writing enhances educational practices with AI tools	109
4.2	Writing processes supported by AI's automation and personalization	115
4.3	Writing quality and authenticity in the age of AI	120
4.4	Writing and educational equity with AI tools.....	124
4.5	Writing integrates AI while preserving human interaction	128
5	FINAL REMARKS	136
	REFERENCES	141
	APPENDIX I – Research credibility.....	154
	APPENDIX II – Scientific publications.....	156

SECTION 1



THE BEGINNING OF MY JOURNEY¹

¹ Image generated using OpenAI's DALL-E image generation tool on November 11, 2023. The prompt used for generation was: "Generate images that represent a female researcher wearing glasses and with dark hair. She's at the beginning of her study path, focusing on education, writing, artificial intelligence, and ChatGPT. The images depict a woman at a crossroads, surrounded by symbolic elements related to her areas of research".

1 THE BEGINNING OF MY JOURNEY

“Consciousness of complexity leads us to realize
that we will never escape uncertainty
and that we can never attain total knowledge:
Totality is not the truth” (Morin, 2015, p. 69).

The journey you are about to embark on addresses areas of knowledge intrinsically linked to the structure of our contemporary societies, which are Artificial Intelligence (AI), Technologies, Languages, and Education. So, I have decided to present my initial path by inviting you to reflect upon a quotation by one of the Nobel Peace Prize 2021 winners, Maria Angelita Ressa, a journalist and author.

“So, who knows what will happen in our May elections? One thing is clear [...] you cannot have integrity of elections if you don’t have integrity of facts. And that is something all of us, all democracies around the world face” (Ressa, 2021). Maria Angelita Ressa said this quotation in an interview on the importance of a free press for PBS NewsHour, a North American evening television news program. As the Chief Executive Officer (CEO) and co-founder of Rappler (Rappler, 2021), an online news website based in the Philippines, the 2021 Nobel Peace laureate has faced constant political harassment and arrests by the Duterte government (Ratcliffe, 2022). Rodrigo Duterte ruled the presidency in the Philippines from 2016 to 2022. He’s known as “The Punisher” due to the high number of extrajudicial killings in his “war on drugs”, an estimate of up to 30,000 people died according to the International Criminal Court (ICC). Ressa was forced to post bail various times in order to remain out of prison. Rappler’s battle for truth and democracy is being charged by the Philippines government with having committed cyber-libel.

The Norwegian Nobel Committee has decided to award the Nobel Peace Prize for 2021 to Maria Ressa and Dmitry Muratov for their efforts to safeguard freedom of expression, which is a precondition for democracy and lasting peace. Ms. Ressa and Mr. Muratov are receiving the Peace Prize for their courageous fight for freedom of expression in the Philippines and Russia. At the same time, they are representatives of all journalists who stand up for this ideal in a world in which democracy and freedom of the press face increasingly adverse conditions (Reiss-Andersen, 2021).

The Nobel Peace Committee acknowledges the need for a reform of social media platforms due to their role in fostering hatred and violence. In Ressa’s speech, she warned about the manipulation taking place on social media platforms, with algorithms prioritizing lies over facts. Ressa highlighted the role of technology and social media platforms in aiding the rise of

such regimes and stressed the need for regulation to curb the impunity that social media enjoys. From Ressa's perspective, technology acts as the accelerant of disinformation and fake news since social media has placed a greater emphasis on circulating misinformation and the spread of hatred over verifiable facts. She calls for a reform of social media platforms since algorithms of amplification and algorithms of distribution have been programmed by humans with coded bias, and to be profit-driven.

The development of algorithms that pose risks also arouses the interest of a highly profitable market, whose financial return and power relations are markedly significant and could already be proven, as in the Brexit elections in the United Kingdom, and for president of the United States, in 2016 and Brazil, in 2018. Social media platforms use algorithms to personalize the content we see by prioritizing information that aligns with our personal beliefs and interests. The phenomenon is called filter bubbles, a term coined by Pariser (2011). It is also described as a state of "intellectual isolation" (Srba *et al.*, 2023, p. 4), negatively impacting democratic discourse. In addition, the creation of informational bubbles in social media is a consequence of AI and improved algorithms, which leads us to interact with and access content primarily from people who have consensual lines of reasoning and opinions (Santaella, 2019). This phenomenon presents the danger that critical issues will get filtered, leaving people unexposed to views different from their own.

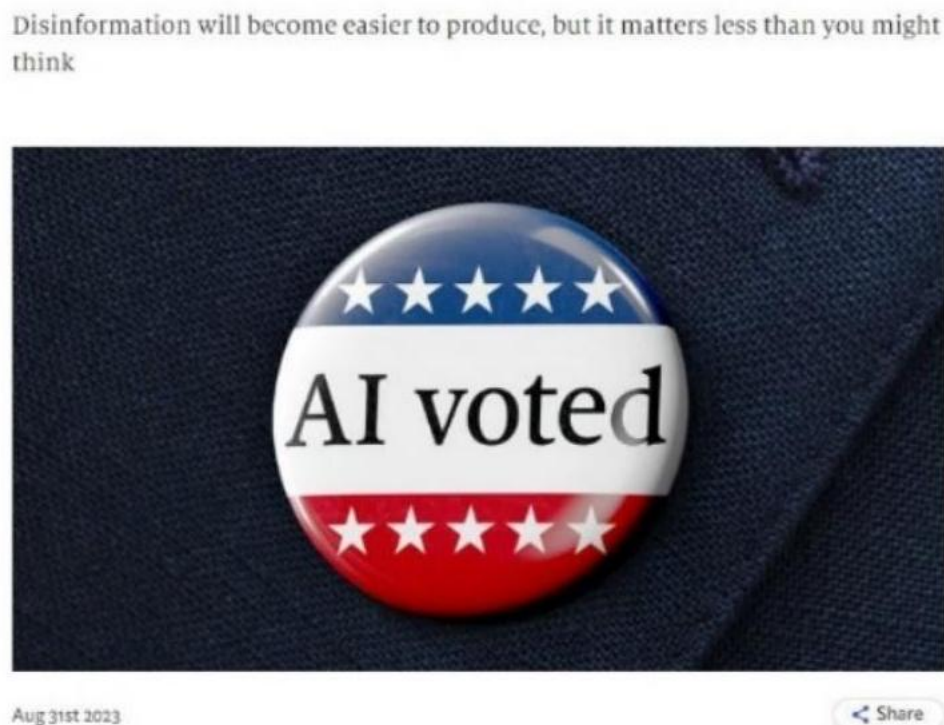
In all these political scenes, we recognize another phenomenon named post-truth (McIntyre, 2018), in which truth loses its relevant character in the formation of public opinion, with a preference for information whose basis lies in beliefs and emotions. Although post-truth (Oxford, 2016), the word of the year 2016, is not a current phenomenon, the ubiquity — the state of being omnipresent, a modern life concept resulting from hypermobility (Santaella, 2013) — enabled by smartphones in our daily lives, ends up scaling it.

During the Brazilian presidential elections in 2022, the advances in AI technologies continued to impact the decision-making processes of many voters who were being bombarded with misinformation (Jeantet, 2022). False narratives include claims about the leftist candidate, Luiz Inácio Lula da Silva, planning to close churches, among other fake news. Also, far-right YouTube channels have collected more views compared to leftist channels, when the candidate and former president Jair Messias Bolsonaro questioned the safety of the electronic voting machines and the fairness of the electoral process. In response to these false allegations, the Superior Electoral Court has empowered itself to ban content that undermines the electoral process, demanding that social media platforms remove such content within an hour or face fines. Luiz Edson Fachin, Brazilian jurist, lawyer, and president of the Supreme Court during

that period, stated that those serious allegations of fraud had no evidence. Fachin highlighted “It is about time to stop misinformation and authoritarian populism that puts the 1988 Constitution in jeopardy (RBA, 2022, my translation)”. During a period of elections filled with misinformation and distrust in institutions, the manifesto entitled *Carta à democracia* (Letters to Brazilians) (Paraguassu; Marcello, 2022) was released in order to restore faith in the democratic process, emphasize the relevance of unbiased information as well as encourage unity among Brazilian citizens.

Again, the United States faces all these concerns regarding disinformation campaigns for the 2024 presidential elections. There is major constant worry expressed in the media due to the rapid spread of misinformation made possible by the advancement of AI. The discussions clearly show the fear that these campaigns may have implications for democracy (see Figure 1).

Figure 1 – How worried should you be about AI disrupting elections?



Source: The Economist (2023).

According to Vallarino (2023), this news article’s author, disinformation is not new in our society, and is not only created by AI. However, he predicts a new scenario with the advancements in generative artificial intelligence (GenAI), because of “[...] models that can spit out sophisticated essays and create realistic images from text prompts—make synthetic

propaganda possible”. The author highlights that there is considerable concern and fear, not only for the 2024 US presidential elections but also for future campaigns in other countries such as India, Indonesia, Mexico, and Taiwan.

The Year 2024 stands as a monumental milestone in the global democratic landscape, marked as “The Ultimate Election Year”. This distinction arises not merely from the frequency of elections but from their extensive reach and potential impact. In this year, an unprecedented number of nations—specifically, 64 countries plus the European Union—will engage in national elections. These elections encapsulate nearly half of the world’s population, about 49%, underscoring their significant democratic engagement. The outcomes of these elections are poised to shape the geopolitical and social trajectories of these nations for years to come, highlighting 2024 as a critical year in fortifying democratic processes and principles worldwide (Ewe, 2023).

In an interview on GZERO World, the attention is also directed to the fact that 2024 is the first US presidential election in the age of GenAI (Bremmer; Stelter; Hemmer, 2023). There are concerns about the potential for AI-text and AI-image generator platforms, for instance ChatGPT (developed by OpenAI) and Midjourney (developed by Midjourney, Inc.), capable of spreading misinformation and disinformation more rapidly and easily than ever (see Figure 2).

Figure 2 – ChatGPT and the 2024 US election



Source: GZero World (2023).

These media experts say “[...] the stakes are incredibly high for truth and democracy” (Bremmer; Stelter; Hemmer, 2023) based on the US previous elections. They mention as

consistent examples of these issues the spread of disinformation in social media platforms in 2016, and the conspiracy theories and baseless claims regarding voter fraud in the 2020 election. They agree on this, due to the amount of “information pollution in the atmosphere” by also referring to the AI-faked images of Donald Trump’s imagined arrest (Higgins, 2023) (see Figure 3).

Figure 3 – Imagined arrest images of Donald Trump created using Midjourney v5



Source: Higgins (2023).

In preparation for the 2024 elections in democratic processes, OpenAI has joined the Coalition for Content Provenance and Authenticity (C2PA)² to support digital content certification standards, helping authenticate AI-produced images and videos. The organization has upgraded its systems to connect users with authoritative election information, including integrating ChatGPT with official election websites (OpenAI, 2024).

OpenAI’s concern regarding the elections involves the responsible deployment and use of its GenAI technologies, including the most recent AI text-to-video generation model. Sora is still a research output that will be launched this year. However, OpenAI has informed that it will not release any technology, including Sora, that could adversely affect worldwide elections or propagate misinformation and biases in 2024. Given the potential for these technologies to be misused, including creating misleading or deceptive content that could affect election outcomes, OpenAI has implemented measures to safeguard against such risks. This includes refining usage policies for AI tools, enhancing the transparency of AI-generated content, and promoting access to reliable voting information. Additionally, OpenAI supports legislative efforts, such as the “Protect Elections from Deceptive AI Act” which aims to prohibit the

² Available at: <https://c2pa.org/>

distribution of deceptive AI-generated media in political advertising, thereby ensuring the integrity of electoral processes (OpenAI, 2024).

In these opening pages, I contextualize the emergence of AI and GenAI technologies within political, economic, and social spheres, highlighting their potential to raise serious ethical concerns—a situation that has dramatically intensified following the launch of ChatGPT. This AI-powered large language model was developed by OpenAI, a North American company established in 2015. Initially founded as a non-profit AI research institution (Open, 2023), OpenAI has articulated its mission to promote and develop user-friendly AI that benefits humanity as a whole. The organization pledges to “freely collaborate” with other institutions and researchers by making its patents and research openly accessible. Supported by commitments exceeding \$1 billion, the company plans a cautious allocation of these funds, particularly in the initial years. The founders are partly motivated by the existential risks associated with GenAI.

On November 30, 2022, OpenAI made ChatGPT accessible to the public. This GPT-3.5-algorithm-based chatbot became a topic of discussion in the mass media because of its capabilities of generating human-like content. When provided a prompt, this AI-text generator can perform a wide range of tasks: text generation and completion; language translation; information summarization; question answering; conversational AI; writing assistance in composing emails, essays, reports or creative writing pieces like stories, poems, jokes; educational support providing explanations on academic topics, among others. The list of possibilities has become endless and its responses can be indistinguishable from human responses. Its continuing massive popularity achieved one million users in only five days after its release (see Figure 4).

Figure 4 – ChatGPT: 1 million active users



Source: Yahoo Finance (2022).

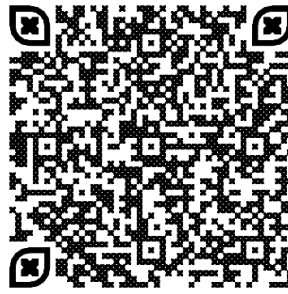
Although OpenAI informs ChatGPT has limitations, it is undeniable that this AI chatbot has achieved a major milestone compared to other platforms. Social media posts, digital newspaper news, YouTube videos, and podcasts started reporting reactions across the United States, Brazil, as well as other countries. Even though I am Brazilian, at the time ChatGPT was rapidly gaining popularity, I was living in the United States.

From September 2022 to May 2023, I was doing my Doctoral “Sandwich” program, *Programa Institucional de Doutorado Sanduíche no Exterior* (PDSE), at Virginia Commonwealth University (VCU) in Richmond, Virginia, as a CAPES³ scholarship holder. When I first arrived at VCU, in fact, since I had started working on my doctoral project in 2020, I used to be told: “I don’t quite understand what your research is about, but it sounds interesting”. This was an extremely common opinion because, although GPT-3-algorithm-based text generators already existed, they did not match the immense popularity that ChatGPT has achieved.

Between mid-2020, marked by the launch of GPT-3, and late November 2022, there was a significant number of AI-writing platforms available on the market: ShortlyAI, JasperAI, Simplified, Writesonic, Wordplay, Hypotenuse.AI, to name a few. There was a concurrent emergence of media and academic discourses. It is crucial to mention the article *Artificial intelligence in academic writing: what is in store with the GPT-3 algorithm?* (Boa Sorte *et al.*, 2021). This article centered its discussion on concerns about the impacts on writing in terms of ethics, creativity, and intellectual property. This scientific paper (see Figure 5) was published by my advisor Prof. Dr. Paulo Boa Sorte, and co-authored by me and our research group members: Prof. Dr. Mário Freitas, Jefferson Santos, and Jamile Dias, on October 8, 2021 and it became a reference after the launch of ChatGPT.

³ CAPES, which stands for *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*, is the publications portal of the Coordination for the Improvement of Higher Education Personnel whose mission is: to promote graduate programs in Brazil through online access to scientific information.

Figure 5 – Article: What is in store with the GPT-3 algorithm?



Source: Boa Sorte *et al.* (2021).

In terms of media discourse, the news article⁴ published by The Guardian on September 8, 2020, was the first piece generated by a GPT-3 algorithm platform reported in the media (see Figure 6). This article raised a multitude of ethical concerns due to the content it generated and questions regarding the potential disappearance of professions, especially in the fields of journalism and cinema.

Figure 6 – First published article generated by GPT-3 large language model



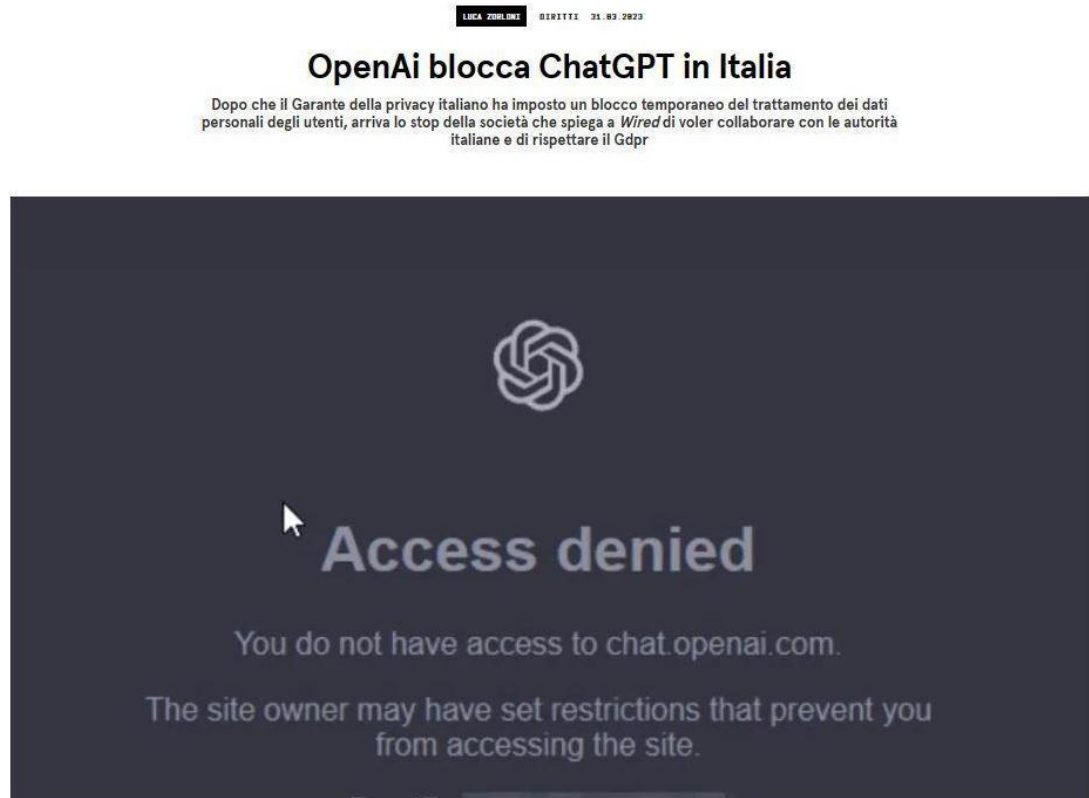
Source: The Guardian (2020).

The amount of media coverage on these issues was relatively limited in comparison to the extensive media discourse since the advent of ChatGPT in late 2022. I recall having frequent conversations with my advisor about the reactions I observed when the topic started being addressed in lectures in various departments at VCU and other US universities. In addition, it was when the number of news and posts I gathered about my theme of research began to increase significantly. The vast majority of those responses follows the narrative of the

⁴ Available at: <https://www.theguardian.com/commentisfree/2020/sep/08/robot-wrote-this-article-gpt-3>

technological phenomenon along human history (Lemos, 2013), in which we find ourselves confronted with a new technology and our overall tendency is to respond with either enchantment or fear. In the case of ChatGPT, many of the first reactions resulted in extreme, negative, and critical attitudes (see Figure 7).

Figure 7 – ChatGPT is banned in Italy



Source: Wired (2023).

At the end of March 2023, Italy decided to temporarily ban ChatGPT (Zorloni, 2023). According to Garante, the Italian data-protection authority, OpenAI could not legally justify the collection and storage of users' personal data to train their algorithms. Italy was the first Western country to block this chatbot over privacy and ethical concerns. Stanzione (2023), the president of Garante, described the following issues with the management of personal data by OpenAI: lack of user information, absence of legal basis for data collection, inaccurate personal data processing, no verification of users' ages, risks to users under 13 years old potentially exposed to inappropriate responses, among others. Despite that, on April 28, 2023, the Garante removed its limit block of ChatGPT, informing that OpenAI had cooperated in responding to the Italian authorities.

The absence of regulation for this AI-technology has fueled discussions about its impacts not only on the social, political, and economic spheres but also in the field of education. Even before Italy banned access to ChatGPT, the New York City (NYC) Education Department had decided to block the AI-powered chatbot. In the first week of January 2023, access to ChatGPT was restricted on devices and networks of NYC public schools (see Figure 8).

Figure 8 – ChatGPT is banned in NYC public schools
NYC education department blocks ChatGPT on school devices, networks

By Michael Elsen-Rooney | January 3, 2023, 8:52pm GMT-3



New York City is blocking access to the artificial intelligence-powered ChatGPT on school devices and networks. | Jakub Porzyski / NurPhoto via Getty Images

Source: Elsen-Rooney (2023).

The reasons for this prohibition were deep worries about potential negative effects on student learning, and about safety and veracity of the generated content. Furthermore, educators feared cheating and plagiarism would become more common and this would make writing assignments obsolete. As the nation's largest school system in the US, NYC's decision to restrict ChatGPT access provokes a ripple effect influencing other school districts. Los Angeles and Baltimore have agreed on this ban and also blocked access to ChatGPT. It worked as a strategy so that other school districts had time to evaluate the benefits and risks of the chatbot (Elsen-Rooney, 2023).

As to teachers' reactions, they express most concerns on rethinking assessment and teaching in light of GenAI technologies. The title of the article *The college essay is dead* clearly expresses major worries and profound fear towards the impact of these technologies in education. The image seems to be precisely selected to highlight all these feelings. The author states concern regarding the historical significance of the essay in humanistic education,

emphasizing its role in teaching research, thinking, and writing skills. Similarly, the article *The end of high school English* reacts unfavorably to the possibilities of the incorporation of Large Language Models (LLMs) in education. The astonishment with the capabilities of ChatGPT becomes an automatic fearful response (see Figure 9).

Figure 9 – Teachers’ reactions towards ChatGPT



Source: The Atlantic (2022).

A central theme discussed in these three articles is the potential redundancy of traditional essay writing as a critical metric for learning and intelligence assessment, given GenAI’s capabilities. The observed reality includes the impact on writing and academic integrity with concerns about the possible obsolescence of writing assignments, particularly in the domain of education, and more specifically in high school and humanistic education. Moreover, the necessity of developing educational policies in view of technological advances is another reality that could not be ignored as well as the necessary collaboration between humanities and technology fields. The articles focus on the practical and ethical considerations of integrating GenAI into a traditionally human-centric domain like education.

In education, the application of AI is present. The sphere of production and dissemination of texts has been appropriated by AI techniques in its various forms of representation, i.e., graphic texts, sounds, drawings, photographs, videos, and text messages on smartphones. AI is defined as something that can “serve the human by optimizing tasks that would take too long to be performed by one or a few people” (Santos; Arruda, 2019, p. 728). It is studied, in this sense, how to program computers to perform tasks that, until then, humans do better. In the educational field, talking about AI is to create space for discussion, for example,

logical reasoning, programming, algorithms⁵, computer language, translations, robotics, artificial neural networks, and more recently, for the first time in history, the writing of academic and literary texts.

By observing the interface of text message writing on smartphones, we can see an example of how AI pattern recognition algorithms work, namely, they predict and suggest the next word to be typed based on what had just been typed. This process is governed by a statistical language model that distributes probability over the sequences of words. Such predictive capability exemplifies the core functionality of Predictive AI, the deployment of Machine Learning (ML) techniques to improve accuracy and efficiency of text entry. The underlying statistical models, for example n-gram models or more complex neural networks, analyze vast amounts of text data to learn probable word sequences (Bengio *et al.*, 2003). As users type, these models apply learned patterns to predict and suggest the next most likely word, thereby streamlining the communication process. Predictive AI encompasses more than the improvement of text messaging, also playing a crucial role in applications including email auto-completion and real-time translation services. These technologies enhance the speed and intuitiveness of digital communication, making it more efficient and user-friendly.

Predictive AI and Generative AI represent two distinct branches of AI technologies with divergent functionalities and applications. While Predictive AI increases the efficiency of text messaging through relevant word suggestions, it differs fundamentally from Generative AI, particularly in the context of text generation in education. GenAI, exemplified by LLMs like GPT-4, goes beyond predicting the next word since it generates coherent, contextually appropriate, and often creative text based on a given prompt. This capability is supported by Deep Learning (DL) — a subset of ML — whose techniques structure algorithms in layers forming an artificial neural network capable of assisting in more demanding writing tasks, such as drafting essays, helping to create lesson plans, or providing personalized feedback on students' work. Unlike Predictive AI in text messaging, which relies heavily on existing data to predict subsequent words, GenAI can synthesize new ideas and articulate nuanced arguments,

⁵ According to Ferrari and Cechinel (2008, p. 15), in the context of computing, in which machines manipulate data from an instruction, “an algorithm can be defined as a finite sequence of steps (instructions) to solve a given problem. Whenever we develop an algorithm, we are establishing a pattern of behavior that should be followed (a norm of action execution) to achieve the result of a problem. For the development of an efficient algorithm it is necessary to obey some basic premises at the moment of its construction: (i) define simple and unambiguous actions; (ii) organize the actions in an orderly way; (iii) establish the actions within a finite sequence of steps [...] Algorithms are able to perform tasks such as: 1) reading and writing data; 2) evaluating algebraic, relational and logical expressions; 3) making decisions based on the results of the evaluated expressions; 4) repeating a set of actions according to a condition”.

making it a valuable tool in educational settings where creativity and critical thinking are essential (Ahmad *et al.*, 2023; Lancaster, 2023; dos Santos *et al.*, 2023).

To appreciate the full spectrum of AI, it is essential to recognize that AI as a field of study has a rich history spanning over 70 years. This extensive background encompasses a broad array of technologies beyond the contemporary focus on predictive and generative models. Historically, AI research has progressed from early rule-based systems in the mid-20th century through various paradigms, including symbolic AI, expert systems, and the latest advances in ML techniques, culminating in today's sophisticated neural network architectures (Russell; Norvig, 2021). Each phase has contributed fundamentally to the diverse applications and robust methodologies observed in current AI technologies.

Nowadays, ChatGPT is considered the most popular LLM based on the algorithm GPT-4, the unlimited subscription-based version. GPT-4 outperforms its previous models because it accepts both text and image inputs and emits text outputs. Besides the multimodality abilities, its capacity to understand and generate more intricate and nuanced content is increased. It can understand more languages and dialects with greater proficiency. Another extremely important improvement is the enhancement of safety features, reducing harmful or biased outputs (OpenAI, 2023a). Its most recent improvements: on September 25, the integration with speech-to-text and text-to-speech technologies. This makes GPT-4 more accessible and user-friendly because the user's voice inputs are converted to text so they can be processed and finally, read out loud (OpenAI, 2023b), and GPT-4o ("o" for "omni"), the most advanced model to date. It is a multimodal system, capable of accepting both text and image inputs and outputting text. This model provides GPT-4-level intelligence and enhances its capabilities across text, voice, and vision, all while delivering much faster performance (OpenAI, 2024).

The available free version, which now also offers limited access to GPT-4o, is based on GPT-3.5 and it can be accessed via the official website, or the mobile app. Its predecessor is the GPT-3, which served as the basis for ChatGPT, has 175 billion parameters. For the purpose of comprehending this number in perspective, let us factor in account previous models, GPT-2, considered cutting-edge and surprisingly large when released in 2019, which had 1.5 billion parameters. Clarifying the understanding about the size of GPT-3, I exemplify with data from Wikipedia, whose English version surpassed on January 23, 2020, 6 million articles, equaling only 0.06% of the data trained by GPT-3.

After originally publishing its GPT-3 research in May 2020, OpenAI selected members of the public and allowed access to the model via an API (Application Programming Interface). Over the course of subsequent days, samples of text generated by GPT-3 began to circulate

widely on social media. After the release of GPT-3, it became commonplace to come across reports on the internet with titles alarming about the possibilities and consequences of this kind of technology for writing. However, extremely far from the serious repercussions that surround our society nowadays. In 2021, when the article entitled *GPT-3: will the world's most powerful writing AI replace a journalist?* (Zaramela, 2021) was published, it addressed the doubt regarding the replacement of this professional, described the experience of using this language model in Portuguese and English, and exemplified with texts initiated by humans and continued by the AI. Since late November 2022, with the extensive outperformance of GPT-3.5 and GPT-4 capabilities, many more professions have been impacted by this technology, in particular, educators and schools. The latest changes that have occurred in society are undoubtedly far-reaching,

As an English teacher for 27 years, I reflect on the impact of yet another technology in the history of the language teaching-learning process, particularly the English language, whose path of methodologies has always been shaped by the development of technologies. Turning to the context of writing, my professional experience teaches me the affordances of an English language learner in search of skills, strategies, and the necessary dispositions for writing. Thus, writing is redefined if we take into consideration aspects such as textual genres, structural issues of the language, and contents, previously seen as the focus in the learning process of writing and that by means of language models can be automatically generated. The GPT-3-generated texts were initiated by humans, but continued by algorithms. With the advancements in NLP, the GPT-3.5 and most importantly, the ones generated by GPT-4 definitely imposed questions that were already bothering educators, schools, and educational institutions. Concepts regarding authorship are part of this debate when it comes to a human-language model writing partnership. AI then draws attention to ethical and intellectual property implications for writing.

The recent refinement of this technology may further instigate reflections on creativity in academic writing. Writing academic papers, whether in secondary or higher education, can be conceived as a source of anxiety and stress for faculty and students (Casanave, 2019; Russell-Pinson; Harris, 2019). The difficulties lie in choosing the focus to be given to the work as well as the search for bibliographical references and citations to substantiate the research, to the writing of the work itself. Students engaged in academic writing need to create texts that are strictly coherent with what the scientific community expects from them “that will evaluate them and that they will surely want to join” — a work that implies time and effort, is linked to the reading of other texts, meets specific standards, and requires the practice of a constant reflective exercise (Pinto, 2018, p. 9).

Technological changes interfere with the learning of writing, imposing on students not only the need to learn specific textual genres, but to continuously learn to write across this variety of technologies, modalities, and contexts (Leu *et al.*, 2016). The authors propose the development of an expanded perspective on writing through the lens of literacies since technologies redefine what writing means, as they are developed. In light of these shifts, this study seeks to explore the intersection of technology and text creation within educational settings, particularly in the advent of GenAI technologies. The following research questions guide this inquiry: How does the integration of GenAI technologies, like LLMs, redefine the concept of writing in educational contexts? What changes in approaches to writing have been observed following the launch of ChatGPT? What educational and pedagogical issues have arisen from the integration of AI-text generators in teaching environments? What ethical concerns are associated with the use of AI-text generators like ChatGPT in education, and how are these concerns being addressed?

I am guided by the view of literacies of the New London group whose manifesto entitled *A pedagogy of multiliteracies: Designing social futures*, published in 1996, recognizes the importance of graphocentric school literacy, but problematizes it for not being sufficient in the face of constant changes, local and global, generated by the impacts of information and communication technologies.

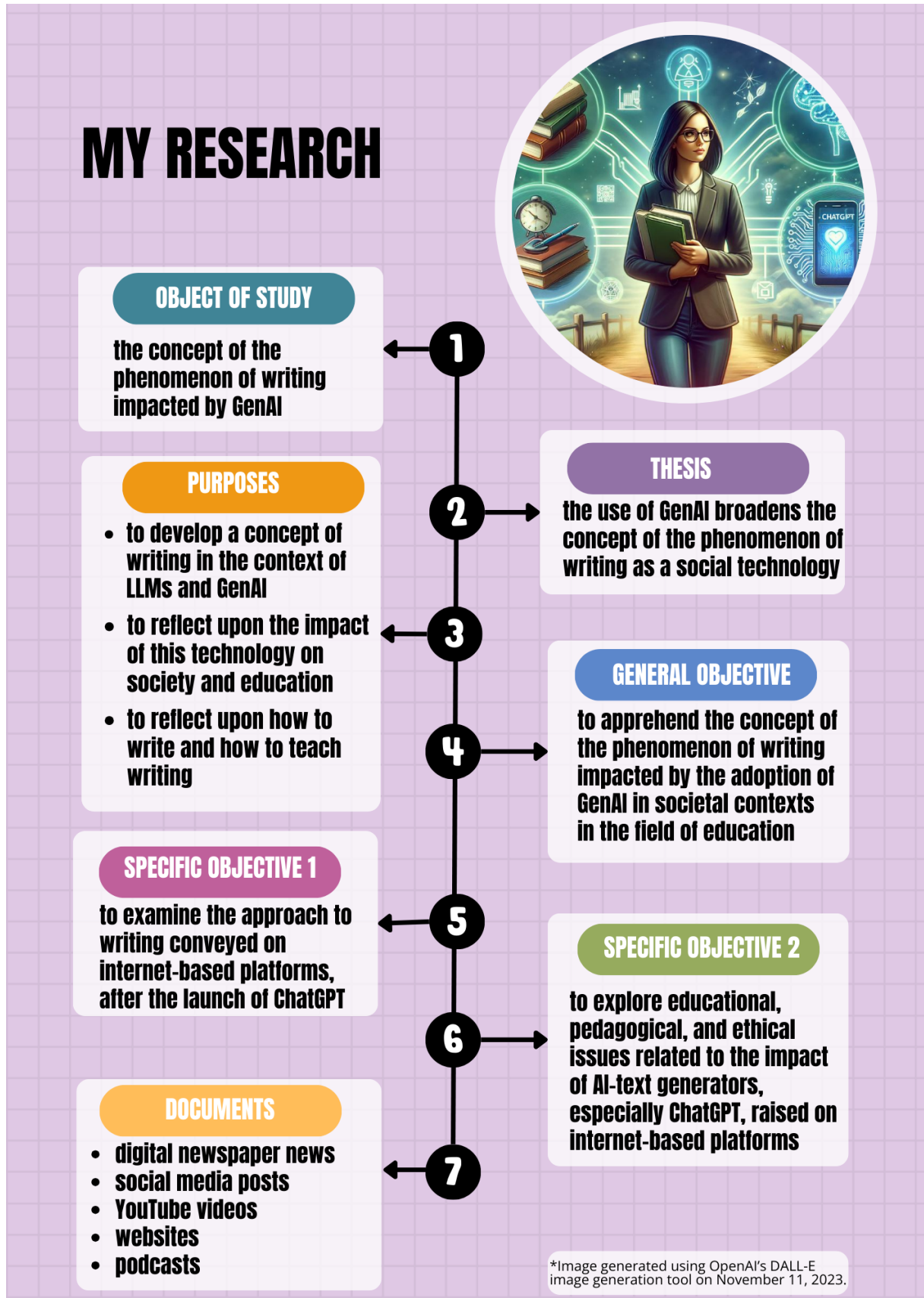
In this pedagogy of multiliteracies, the proposal is the semiotic study of texts, with different ways of producing, transmitting and consuming them. The group is based on the fact of the “immense linguistic, cultural and social diversity of today’s world and how this diversity has become increasingly constitutive of social life” (Kalantzis; Cope; Pinheiro, 2020, p. 117); and also, on the fact that the written text, as never before possible, integrates with images and sounds, making possible an increasing multiplicity and integration of ways of constructing meaning, due to the multiplicity of communication media.

The launch of ChatGPT has undoubtedly marked a turning point for further transformations in writing. Writing has always been impacted by technologies and this AI-chatbot highlights the already existing need for discussion taking into consideration ethical implications, intellectual property, creativity and writing affordances. These are all aspects that integrate writing as a social practice. To expand my perspective upon this phenomenon, I understand it is crucial to apprehend the reality that surrounds it toward the possibility to contribute to the generation of new knowledge both scientifically valid and socially relevant (Petraglia; Moraes, 2022). The reality perceived and investigated in this study is the concept of

writing in the GenAI context, undergoing one more of its various transformations along human history.

Considering this context, the **object of this study** is the concept of the phenomenon of writing impacted by GenAI in the field of education. My thesis aims to support the proposition that the use of GenAI broadens the concept of the phenomenon of writing as a social technology. The **purposes of my research** are to develop a concept of writing in the context of LLMs and GenAI; to reflect upon the impact of this technology on education; and to reflect upon how to write and how to teach writing. The **general objective** is to apprehend the concept of the phenomenon of writing impacted by the adoption of GenAI in educational contexts. Specifically, this study aims to examine the approach to writing conveyed on internet-based platforms, particularly after the launch of ChatGPT; and to explore educational, pedagogical, and ethical issues related to the impact of AI-text generators, especially ChatGPT, raised on internet-based platforms. The research utilizes as data sources **documents** such as digital newspapers news, social media posts, YouTube videos, websites, and podcasts (see Figure 10).

Figure 10 – Research concept map



Source: created by the author (2023).

Bearing the above in mind, I present Complex Thinking as an epistemological and methodological framework for carrying out this investigation. Through the lens of Complex Thinking, the object of my study is considered a phenomenon. The term phenomenon is defined as life experiences that emerge from our social and cultural interactions (Ravagnoli, 2017). Complex originates from the Latin term ‘complexus’ and signifies ‘woven together’. Considering Morin (2015) and adopting a thought “the least mutilating possible”, respecting the investigation demands, proper to scientific knowledge, and the reflection requirements proposed to philosophical knowledge.

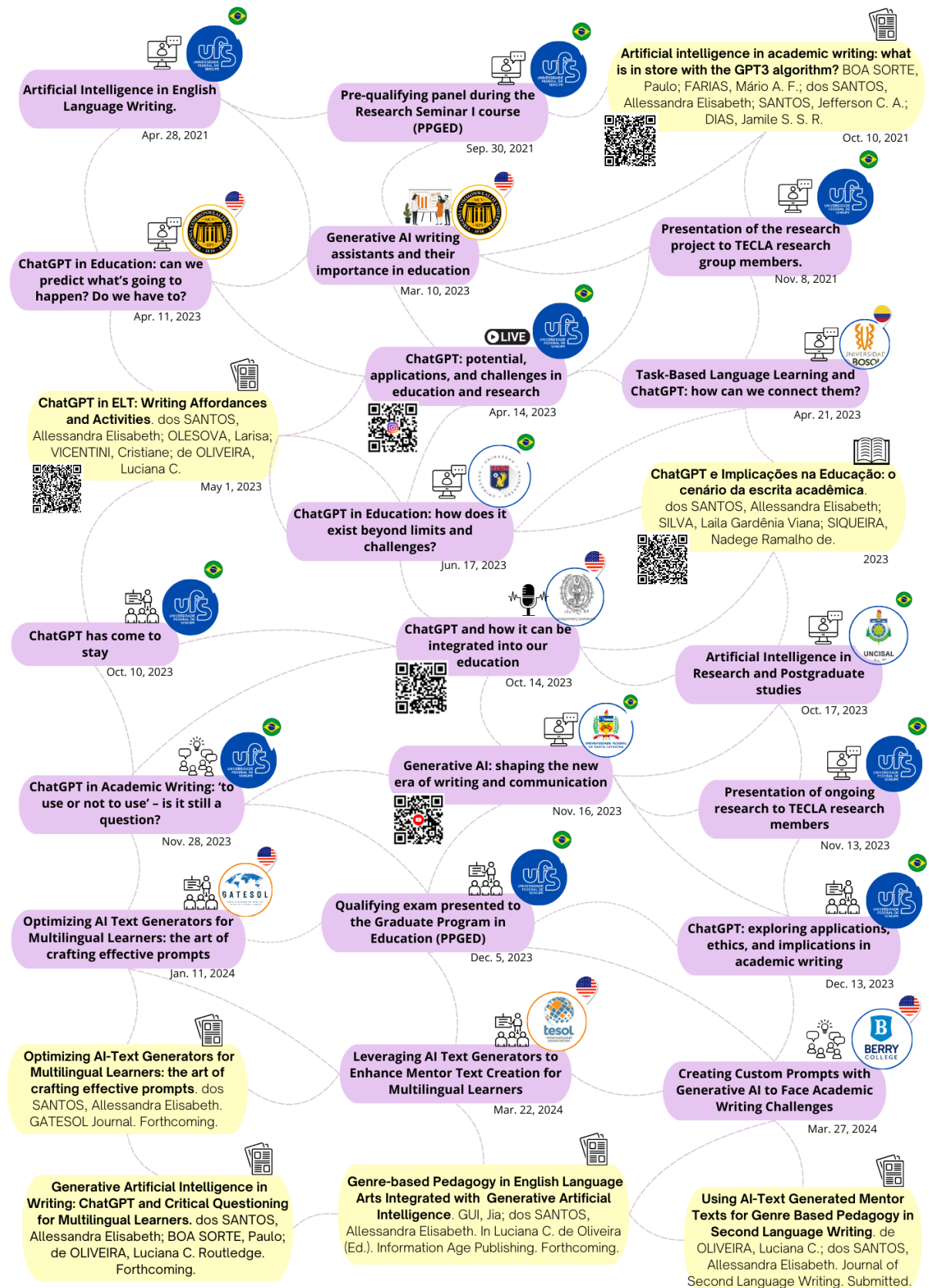
Morin (2000) understands that the meaning of words changes according to the context used, and in linguistics, the meaning of a text is understood only by the context in which it is found. Thus, words and information, writing itself, might not be understood if isolated from the context of our society, our knowledge, and our culture. We should therefore be motivated by a principle of thought that allows us to connect things that seem separate to us in relation to each other. The study of writing should not be regarded as an overly specialized field in isolation. Based on Complex Thinking, the study of writing cannot be done in a way that does not consider the aspects inherent to it in the school environment but also cannot happen in a disconnected way from the social and communication scenario. Education is integrated in the context of social and technological changes whose uses impact on the evolution of writing. According to the holographic principle, “society as a whole appears in each individual, through language, culture, and norms” (Morin, 2000, p. 16). In the recursive ring principle, products and effects are both producers and causers of what produces them: “Human individuals produce society in, and through, their interactions, but society, as an emergent whole, produces the humanity of these individuals by taking language and culture apart from them” (Morin, 2000, p. 16). Such statements explain the transition of the various concepts of what is meant by writing, from writing on paper to the computer screen; after the internet, appropriating multimodal characteristics and, later, with social networks, as a social practice, justifying the relevance of researching the meanings about writing taking into account the scenarios that technologies integrate socially.

Thus, I justify the insertion of my proposal in the research line Technologies, Languages, and Education of *Programa de Pós-Graduação em Educação* (PPGED), whose studies focus on problematizing and investigating the relationships between education and communication processes, considering oral, written, analog and digital languages in educational practices, in face-to-face and distance learning modalities. My motivation for pursuing this research theme is due to both my personal and professional interests in English language

teaching and learning and also, because of my academic background. My contact with the English language as a learner started when I was 10 years old in a language course, in 1986, and as a teacher, when I started teaching in language schools in 1996. In 2003, even though I held a degree in Dentistry, completed in 2001, at UFS, and, at the time, I had already been working as an English teacher for 7 years, I decided to start a degree in English at UFS. In the period, between 2011 and 2020, when I worked as a pedagogical coordinator for Elementary and Middle Years, in a bilingual school (Canadian education system) in Aracaju, I expanded my contact with the English language by guiding the implementation of English programs: Language Arts, grades 1 to 9, and also Science and Math, since they are subjects taught in English in this institution. I realized my growing connection with the field of Education, which led me to hold a Post-Baccalaureate Diploma in Education at the University of Winnipeg, in 2014. Upon my return to UFS, as a substitute professor at the Department of Modern Languages and coordinator of subjects from the Modern Languages Department of the Distance Higher Education Center, *Centro de Educação Superior a Distância* (CESAD), between 2017 and 2019, I taught subjects such as Written Expression in English I; English Language II, III, IV and VIII, among others, and I worked as a tutor for English Language undergraduate students at CESAD, advising them in the writing of their scientific articles as the final paper. Allied to the challenges and experiences of my teaching practice, I also see as reasons for my interest in the theme: the writing of my Master's thesis in Education, whose title is Representations of English teachers on technologies and their relationship with teaching practice, defended in 2020, in addition to my participation as a member of the study and research group Technologies, Education and Applied Linguistics (TECLA), scenarios that constantly reinforce my interest in the Education and Communication research lines; Languages and Technologies in Education; Language and Society.

In the context of Complex Thinking, the relationship between subject and object is by interdependence. This implies that the subject's perception and understanding of the phenomenon investigated do not seem disconnected. With reference to this epistemology and methodology, the researcher is treated as a research participant. As a result, it is relevant to describe my path since I started investigating this object as well as the in-depth look at it while close investigation and interaction during collaborative writing. All that allowed me to view my object of study from different perspectives (see Figure 11).

Figure 11 – Scientific publications and presentations



Source: created by the author (2023).

The credibility of this research was established from the onset of my doctoral journey, through continuous guidance from my advisors, reflections stemming from discussions in our research group meetings, and oral communications of the ongoing project at conferences, seminars, and panels, as outlined in Appendixes I and II.

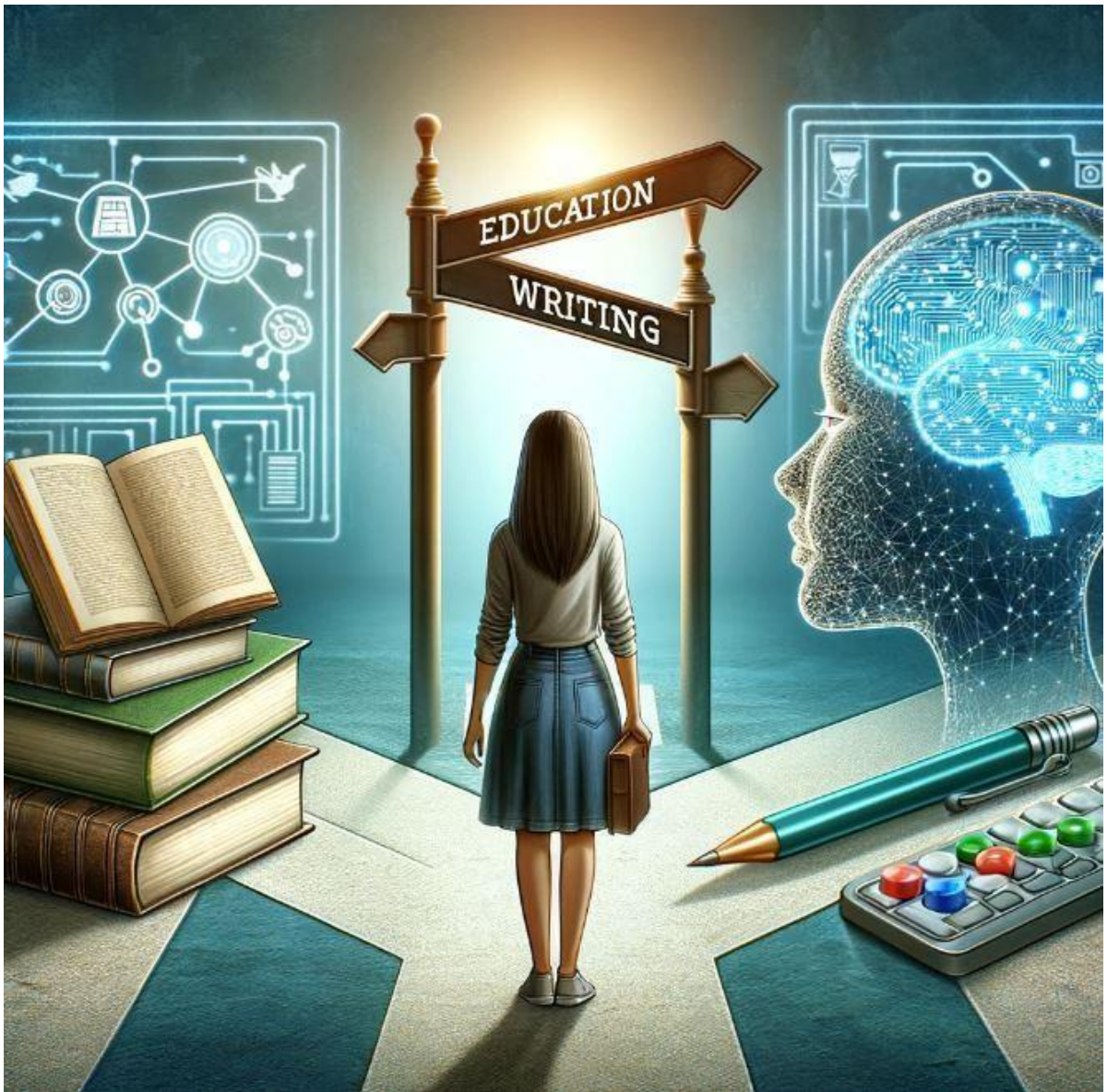
As theoretical bases to reference this study are Morin (2015), Petraglia (2020) and Petraglia and Moraes (2022) for Complex Thinking. Bazerman (2023), Boa Sorte (2018), Fischer (2021), Dibbell (2010), Christensen (2012), Kist (2005), Leu *et al.* (2016), Kalantzis and Cope (2024) and MacArthur *et al.* (2016) as authors for writing. In the area of GenAI and writing, Boa Sorte *et al.* (2021), Kalantzis and Cope (2024), dos Santos, Boa Sorte & de Oliveira (Forthcoming). The theorists for GenAI and ChatGPT are Santaella (2023) and Wolfram (2023). In the sphere of multiliteracies, the authors are Kalantzis, Cope and Pinheiro (2020), Cope, Kalantzis and Searsmith (2020), Cope and Kalantzis (2000) and Kalantzis and Cope (2023, 2024).

Methodologically, this study is described as qualitative because it emphasizes the interconnected and emergent properties of human experiences. This qualitative research is conducted in light of Complex Thinking (Morin, 2015) as epistemology and methodology in order to pursue this path of uncertainty, innovation, provisionality, and randomness. This is a documentary and bibliographic research as regards data sources and gathering procedures. The data are documents selected on internet-based platforms, whose narratives address GenAI and its relation with education and writing as well as ChatGPT and writing. In view of this, I present Analytical Entwining integrated with GenAI (adapted from Boa Sorte *et al.*, 2023; dos Santos; Boa Sorte; de Oliveira, forthcoming) as the method of interpretation for this investigation. While upholding ethics and scientific rigor, its flexible nature provides researchers with four to-and-fro movements as they engage with data.

I continue this study presenting my methodological path in the following section. I describe the characteristics of Complex Thinking (Morin, 2015), the epistemology and methodology I follow, as well as the data gathering procedures and the method of analysis. In section two, I narrate the change of course, considered inevitable from the Complex Thinking perspective and given the current context of the object of my investigation, and also propose a method of analysis integrated with GenAI: Analytical Entwining integrated with GenAI (adapted from Boa Sorte *et al.*, 2023; dos Santos; Boa Sorte; de Oliveira, forthcoming). In section three, I present and discuss the theoretical constructs that helped me achieve the first specific objective: to examine the approach to writing conveyed on internet-based platforms, particularly after the launch of ChatGPT. In section four, I present and discuss the theoretical

constructs that helped me achieve the second specific objective: to explore educational, pedagogical, and ethical issues related to the impact of AI-text generators, especially ChatGPT, raised on internet-based platforms. Finally, in my final remarks section I present the concept of the phenomenon of writing impacted by GenAI that emerged from this research conducted through the lens of Complex Thinking principles (Morin, 2015). Referring to section one epigraph, I pursue this path having in mind aspects Morin (2015) acknowledges as essential for doing research: uncertainty is inherent to human existence and understanding; simple explanations or models cannot apprehend realities; and the truth is not found in total understanding, but perhaps in the recognition of the limitations of our knowledge.

SECTION 2



METHODOLOGICAL PATH⁶

⁶ Image generated using OpenAI's DALL-E image generation tool on November 11, 2023. The prompt used for generation was: "Generate an image that represents a researcher in her initial path of study. Her investigation focuses on education, writing, artificial intelligence, and ChatGPT."

2 METHODOLOGICAL PATH

“Do not forget that reality changes,
do not forget that the new may happen,
and it will happen no matter what”
(Morin, 2015, p. 83).

In navigating research paths, it is recommended to maintain an open mind towards necessary, gradual, but oftentimes, abrupt transitions that scientific research may undergo in the course of time. Whenever actions are carried out, methodological choices have to be made (Morin, 2015). Choosing initial and subsequent strategies in scientific investigations implies awareness of the existence of risks and uncertainties as constant challenges.

To fully understand the implications of these choices, we need to revisit the concepts of epistemology and method (Petraglia, 2022): Epistemology, from the Greek: *episteme* (knowledge) and *logos* (study), is the philosophical domain dedicated to how science and humans acquire and justify their knowledge. It embodies the philosophy of science or the theory of knowledge, aiming to elucidate its origins, logical foundations, structure, and value. An epistemological perspective seeks to identify the essential requirements and conditions for understanding a statement. Method, from the Greek term: *methodos* (path or way) refers to means or manner, a set of organized strategies and/or procedures. It includes the methodology with its techniques and materials that we employ to reach a point, achieve a goal, or address a problem.

As the epistemological and methodological framework of my study, I follow Complex Thinking proposed by Morin (1990, 2015). In this section, I address indispensable elements that support me throughout the designing of this investigation and the building of my path in light of this epistemology. First, I present the fundamental principles, also known as cognitive operators, which continuously shape my journey as a researcher guided by Complex Thinking. In the second subsection, I describe the nature of research and the questions that help us navigate the methodological procedures along the study. In the two following subsections, I narrate the course change, expected due to the uncertainty trait within Complex Thinking, and the designing of the new path in my research journey. I conclude this section by presenting the method of interpretation for this investigation: Analytical Entwining integrated with GenAI (adapted from Boa Sorte *et al.*, 2023; dos Santos; Boa Sorte; de Oliveira, forthcoming), and explaining the four to-and-fro movements I follow as I collaborate with ChatGPT to engage with my research data.

2.1 Complex Thinking and its core principles

Upon first examination, the term “complex” tends to lead to erroneous understanding. The notion that ‘complexity’ primarily expresses our discomfort and confusion suggests that the word carries a heavy semantic burden and encapsulates uncertainty and disorder. Complex Thinking is an approach to understanding the world that acknowledges, embraces, and attempts to comprehend the intricate web of relationships, interactions, and interdependencies that constitute reality (Morin, 2015).

Complex Thinking stands in contrast to reductionist thinking, which simplifies and separates phenomena into discrete, isolated parts, often neglecting the richness of connections and the unpredictable dynamics that emerge from the whole. It rejects the oversimplification of reality, highlighting that complexity cannot be reduced to a single law or simple idea. Instead, he argues for acknowledging the multidimensional, intertwined nature of reality, which cannot be fully apprehended by reductive thinking (Morin, 2015).

Although Complex Thinking does not offer a prescriptive solution for unexpected events, this epistemology encourages alertness, responsibility, and intellectual rigor, reminding us that changes are inevitable and should be anticipated. In accordance with what Morin (2015) referred to in the epigraph of this section, the presence of elements such as randomness, indetermination, and uncertainty is the absolute certainty in life. “In some ways, complexity always relates to randomness” (Morin, 2015, p. 35). So, we need strategies in order to pursue our research journey. It is not uncommon to mislead ourselves by running on autopilot and performing planned actions to solve simplified issues with simplifying thinking. This is essential in order to carry out research: steps planned to reach goals as long as random situations do not arise during the course of the study. The need for strategies aligned with Complex Thinking represents decisions and challenging choices leading to risky and unclear actions. However, Complexity focuses on an initial point in an investigation, allowing for broader actions that are less restricting and limiting, and simplifying perspectives.

This approach encompasses a range of principles, acknowledging the coexistence of order and disorder as inherent to human essence and experience. Importantly, Complex Thinking does not oppose clarity, order, or determinism. Nevertheless, what distinguishes this epistemological and methodological foundation from reductive paradigms is the fact that these three elements, while valuable, are seen as insufficient, since planning does not assure the attainment of discovery, knowledge, or action.

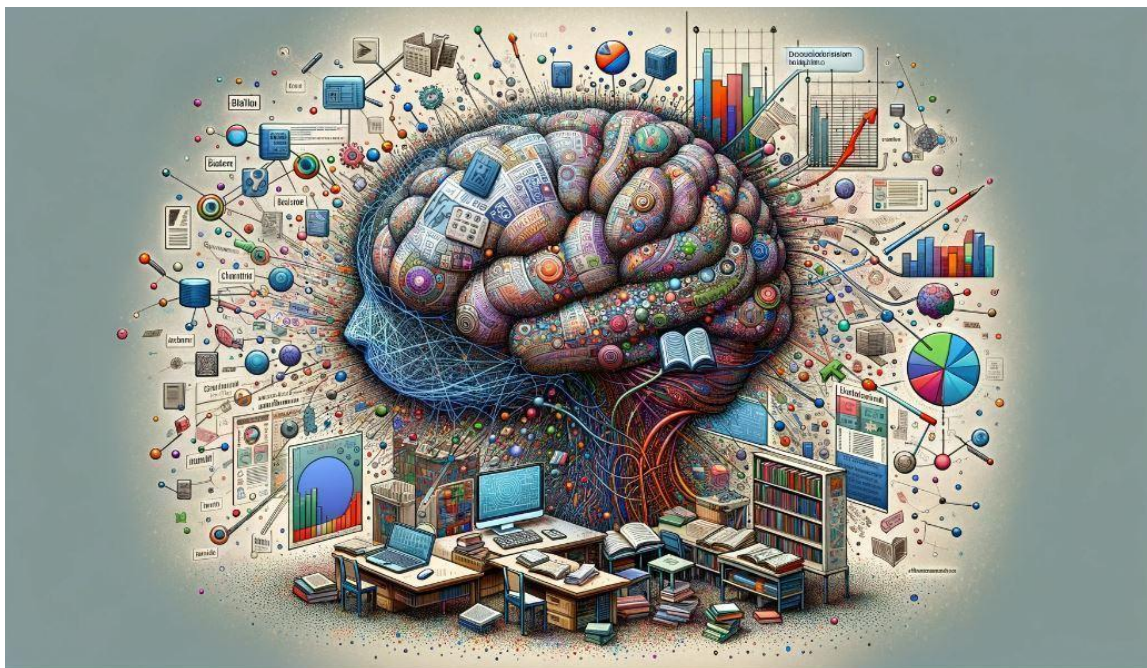
I present the fundamental principles that continuously shape my journey as a researcher guided by Complex Thinking. The first, the dialogic principle, suggests that seemingly opposing elements or concepts can exist in a mutually beneficial, complementary relationship (Morin, 2015). This principle is a cornerstone in the study of complex systems, where dualities are not only inevitable but also essential for understanding the true nature of a phenomenon. The dialogic principle encourages a form of complex thinking that acknowledges and embraces these dualities, rejecting oversimplified views of reality that categorize things as merely “black or white”. Instead, it promotes a nuanced understanding where contradictions can coexist and inform each other.

The recursive principle plays a crucial role in conducting research that adopts Complex Thinking (Morin, 2015). This principle is central to this epistemological and methodological approach because it challenges linear and reductionist ways of understanding a phenomenon. The recursive principle refers to a process where the products and effects are simultaneously cause and effect; product and producer. In simpler terms, it describes a situation where certain processes or phenomena are both the cause and the effect of each other, creating a continuous loop of interaction and influence. In sociology or anthropology, recursive processes are observed in how cultural norms shape individual behavior, and in turn, how individual behaviors can transform cultural norms over time.

Holographic is the third principle (Morin, 2015). This principle highlights the interconnectedness and interdependence of parts within a whole. Changes in one part can have significant implications for the whole system. It suggests that in complex systems, every component is not merely a part but also contains the entire system. This concept is inspired by the nature of holograms, in which every piece of the hologram holds a complete image, though in a reduced form. Unlike traditional perspectives that view parts and wholes as distinctly separate, the holographic principle suggests that each part reflects the whole. This means understanding a part of the system requires considering its relation to the whole system. In addressing complex issues, this principle suggests that solutions should not only focus on parts of the problem but also consider the systemic nature of the issue, understanding how each part relates to and impacts the whole. In education, this principle emphasizes the importance of understanding individuals or units in the context of the larger system, recognizing that each element reflects and contributes to the larger picture. Morin’s holographic principle thus provides a crucial lens for understanding complexity in natural, social, and cognitive systems, advocating for a more interconnected, systemic view of the world.

In Complex Thinking, each principle contributes to the understanding of the nature of phenomena experienced in life. The holographic principle suggests that each part contains the whole, while the recursive principle emphasizes the self-producing and self-organizing nature of systems. Additionally, the dialogic principle recognizes the coexistence and interaction of complementary and contradictory forces. Collectively, these principles depict processes or phenomena as complex, adaptive, and evolving entities, where understanding emerges from recognizing the interconnections among the parts, rather than from isolated interpretation, forming the notion of system.

Complex Thinking, therefore, is not solely a cognitive process (see Figure 12) but an intellectual stance that challenges the thinker to embrace the multifaceted, intertwined, and often contradictory nature of reality. It is a call to move beyond the comfort of certainty and simplicity and engage with the full spectrum of complexity that defines our world. Morin (2015) advocates for a kind of thought that is agile, adaptable, and capable of navigating the inherent complexities of the world we inhabit, with an aim not to eliminate complexity but to better understand and work within it.

Figure 12 – My research in light of Complex Thinking⁷

Source: created by the author using DALL-E (2023).

What constitutes the reality of this study is the complex tangled web of relationships, interactions, and interdependencies among writing, schools and education, AI-text generators, and societal contexts represented by the phenomena of digital newspaper news, social media posts, YouTube videos, podcasts, and websites. In consideration of the unpredictability and transdisciplinary of this reality, I aim to apprehend the concept of the phenomenon of writing impacted by the adoption of GenAI in societal contexts in the field of education in light of the Complex Thinking to achieve the following purposes: to develop a concept of the phenomenon of writing in the context of LLMs and GenAI; to reflect upon the impact of these technologies on society and education; and to reflect upon how to write and how to teach writing.

⁷ Image generated using OpenAI's DALL-E image generation tool on November 11, 2023. The prompt used for generation was: "Generate more images taking this *previous prompt into account but also bearing in mind that epistemology of Complex Thinking does not separate contexts in layers since it believes it is all connected like systems that integrate with one another. This means it is hard to know when one context or system starts or ends". *Previous prompt: I'm a researcher in the area of education, languages and technologies and I'm writing a scientific paper. I want to include an image in this paper that, in light of Complex Thinking (Edgar Morin), shows I'm organizing a section of this paper starting from a macro contextualization of social, political and economic contexts. Then, I focus my view on societal contexts in the field of education. So, I address AI algorithms and Generative AI impacting elections, free press and democracy for my social, political, and economic contexts. In addition, I focus on the impact of generative AI, Large Language Models on writing regarding assessment and teaching."

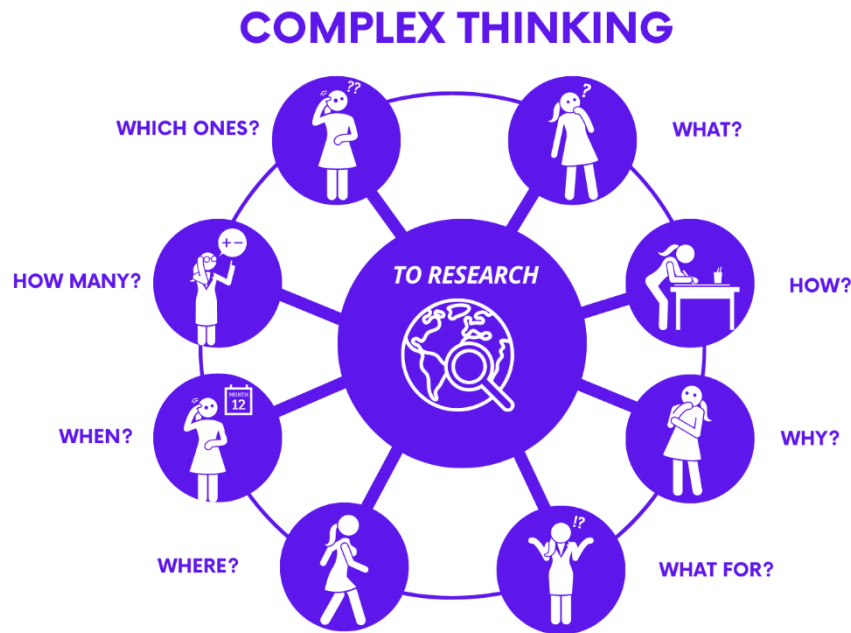
2.2 The nature of research

In view of Complex Thinking, researching means to construct or revise, and synthesize knowledge on a specific subject, issue, process, or observed phenomenon, concerning a particular problem that grabs our attention and compels us to want to delve deeper into its investigation. This accumulated body of knowledge becomes a scientific narrative about the researched phenomenon, thus bringing order to the previous and inner chaos that aroused our curiosity and prompted us to investigate. However, the knowledge developed here goes beyond the everyday understanding of the objectified reality. It belongs to what we term as scientific knowledge because it stems from scientific research carried out in a more rigorous, consistent, organized, and coherent manner.

In other words, it arises from inquiry, a more systematized, empirical, validated, and refined investigation, regardless of its quantitative, qualitative, or mixed nature. What's crucial to note here is that producing scientific research always requires a certain discipline and a particular scientific rigor, ensuring that events and facts are not left to fate. And today, we understand that the more a country invests in scientific research, the more it progresses socially, economically, technologically, and culturally speaking (Petraglia; Moraes, 2022). As always, it's essential to ensure that the translated content retains your intended meaning and fits within the context of your article.

Complexity does not conform to predefined frameworks or wholly standardized practices. This does not mean that we are devoid of tools, procedures, or techniques. Rather, it suggests that we should not prioritize method over experience, as there is no single route or uniform way to think, investigate, invent, or gain knowledge. However, in order to conduct research in light of Complex Thinking, some questions have to be answered (see Figure 13) (Petraglia; Moraes, 2022).

Figure 13 – Complex Thinking: research guiding questions



Source: created by the author based on Petraglia and Moraes (2022).

Embracing Complex Thinking implies that the nature of research should not be strictly framed and linear, as it is based on dialogic, recursive and holographic principles, and the notion of system. However, the research guiding questions are meant to be viewed as helpful to the methodological procedures, enabling researchers to navigate through an investigation.

2.3 The change of course

In light of Complex Thinking, the journey of a research is seen as one that unfolds while one is walking. Therefore, where at any given moment, in response to emerging situations, there might be a need for a new decision: to embark on a new path or to take a different fork in the road (Morin; Motta; Ciurana, 2003).

When I started my doctoral program, LLMs were already accessible to the Brazilian public. AI-writing assistants based on GPT-3 algorithms could be utilized temporarily at no cost to the user. Although there were serious worries regarding ethical aspects (see Figure 14) surrounding the adoption of AI platforms for text generation, they seemed to be preliminary concerns considering what the media reported. Prior to the launch of ChatGPT, the topic appeared to be in the initial phase, given the low frequency and quantity of media publications.

Figure 14 – GPT-3 in journalism



Source: Zaramela (2021).

The article entitled “GPT-3: Will the world’s most powerful writing AI replace a journalist?” was published approximately six months after the launch of GPT-3. Within this publication, the model is portrayed as a groundbreaking advancement in the field of GenAI, with significant implications for journalism and other professional fields. It highlighted the prevalent fear that this technology might signal the end of the journalism profession. It took an additional eight months for the Brazilian television media to discuss the topic on a national scale (see Figure 15).

Figure 15 – AI: *Fantástico* News report

Source: Globo (2021).

The news report is about a Canadian who participated in a project during the COVID pandemic. The project, called December, used AI technologies to simulate exchanging messages with his fiancée, who had passed away 8 years before this report. This news report exposes the risks pointed out by specialists in the development of increasingly advanced AI and questions the ethical limits of its use. The concerns seem to revolve around the ethical implications and potential psychological effects of using AI to simulate interactions with deceased individuals.

In 2021, I had defined my study goals and I was working on my research project, reading the literature, designing the field research, and familiarizing with UFS's Ethical Committee in Research, *Comitê de Ética em Pesquisa* (CEP), updated ethical procedures. As a researcher, I value the ethical aspects when conducting scientific research. Due to that, in that same year, I submitted the research project to the Institutional Review Board of the Federal University of Sergipe in June and only after its approval⁸, data collection was meant to begin. The approval was given at the end of year 2021, enabling me to commence field research.

These plans were placed on hold after I was granted a PDSE CAPES scholarship. In September 2022, I relocated to Richmond, Virginia (USA), to begin my "Sandwich" doctoral program at Virginia Commonwealth University (VCU) under the supervision of Prof. Dr. Luciana C. de Oliveira. In consultation with my advisor, we decided to delay the field research so I could experience this unique educational opportunity to the fullest and expand my understanding of the object of my study.

During my interactions with faculty and students at the School of Education (VCU), I frequently shared information about my research. Initially, responses were a combination of surprise, curiosity, and confusion, as the theme was unfamiliar to those I engaged with. This perception gradually shifted subsequent to the introduction of ChatGPT on November 30, 2022.

By December 2022, I faced a crucial decision regarding the need for financial support to utilize a GPT-3 platform. This platform was essential for the continuation of my research post the "Sandwich" program and the initiation of data collecting process. During data collection, the participants of an academic writing course would use a platform or application with the GPT-3 language model, such as ShortlyAI⁹. The selection of the natural language model, the GPT-3 writing assistant, was pivotal due to its potential impact on the research

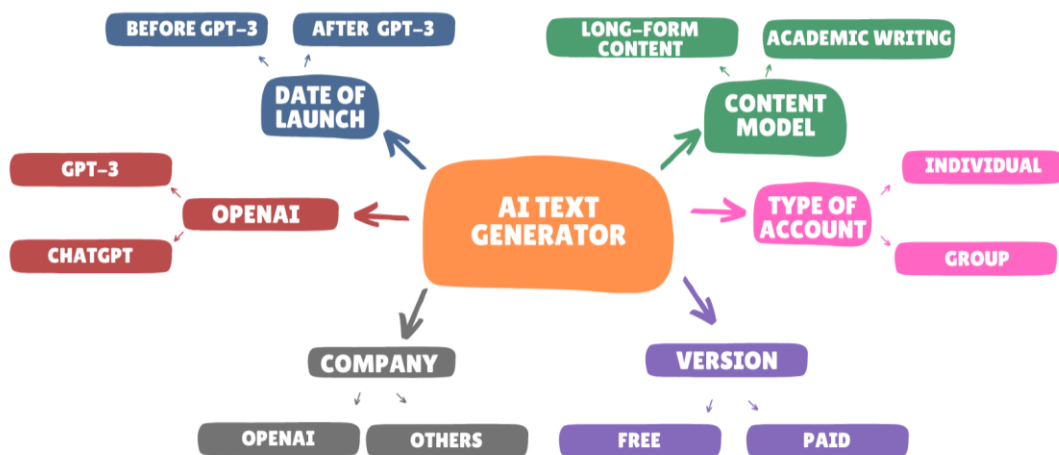
⁸ This research was approved by the Institutional Review Board of the Federal University of Sergipe-UFS (CAAE 50114121.2.0000.5546) and received substantiated opinion n. 5.173.020.

⁹ ShortlyAI is a text generator application, in which the user just types in initial sentences and by clicking the "write for me" button, the AI writer takes over the writing. Available at: <https://www.shortlyai.com/>. Accessed on: May 12 2021.

outcomes. This thinking process involved rigorous inclusion and exclusion criteria to select the most suitable AI writing assistant from the various options available in the market. The selection of the platform posed a particular challenge due to the vast number of options available and the changing criteria throughout the study.

In the context of selecting an AI text-generator, mind mapping proved instrumental. A mind map visually organizes the selection criteria into color-coded branches (Buzan, 2024). The green color corresponds to the criterion of the content model, indicating the GenAI's ability to handle various writing styles and formats. Following the clockwise direction, the pink branch represents the types of accounts available—individual or group. Purple is used to denote the version of the software, distinguishing between free and paid options, which is critical for budget considerations. The gray highlights the company producing the technology, essential for understanding the support and innovation behind the product. The need to select the most advanced model is highlighted in the red branch. Finally, the blue branch represents the date of launch, indicating the software's currency and relevance in the fast-evolving field of AI (see Figure 16).

Figure 16 – AI text generator selection criteria



Source: created by the author (2023).

This approach serves to clarify the decision-making process and also highlights the strategic thinking involved. At the end of 2022, after progressing through many relevant steps in developing my research, my advisor and I began to recognize the need to reconsider my research trajectory.

This realization was further catalyzed by the substantial impact of ChatGPT, which achieved 100 million users within just two months of its release. Additionally, the release of

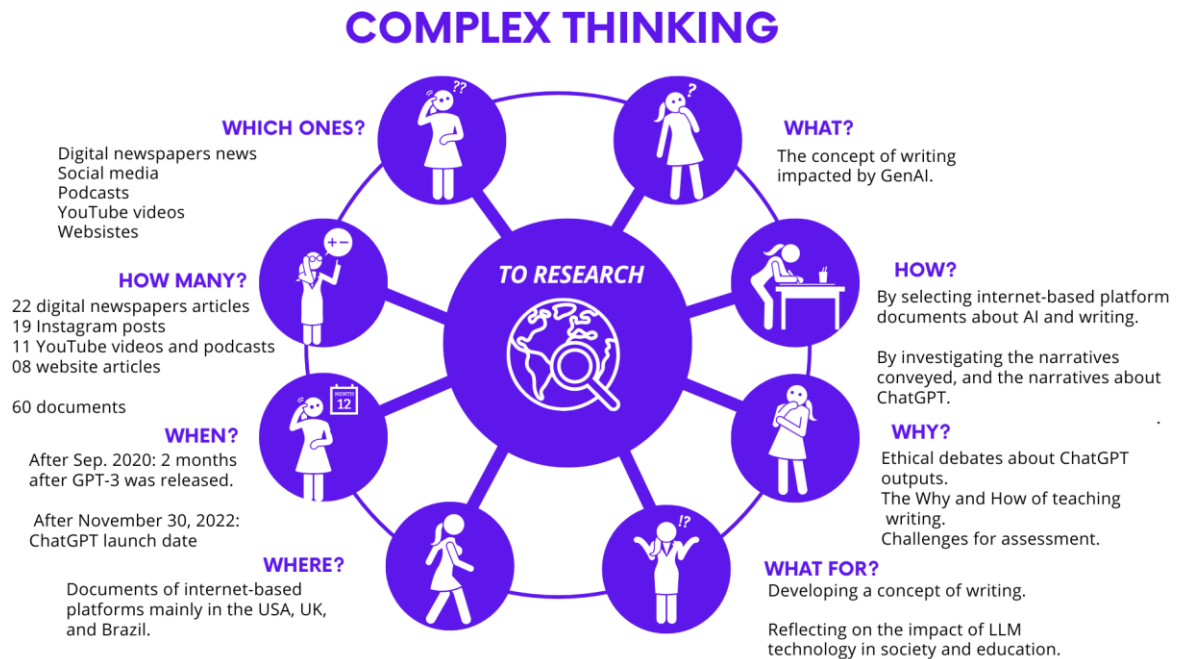
GPT-4 by OpenAI on March 14, 2023, and the announcement of the potential launch of GPT-5 during the same event, compelled us to reassess the research direction. These developments highlighted the rapid advancement of GenAI technologies and their implications for my study.

2.4 Redesigning my path

A journey of understanding certainly begins with an intent and anticipates an end. It is crucial to recognize the role of theory and its relationship to method. Theory is not knowledge itself but rather a facilitator of knowledge, which corroborates Morin's movement. It is not an endpoint but an opportunity for commencement, which is a recursive movement. Theory is not an answer but provides a means to address a problem. A theory only serves its cognitive purpose and comes to life through the active mental engagement of the individual. This active engagement, fostered through the dialogic and recursive interactions (Morin, 2015), is what makes the concept of method essential (Morin; Motta; Ciurana, 2003, p. 23-24).

The flexible nature of Complex Thinking expresses a convergence of events stemming from the intrinsic complex features inherent to the phenomena in my study: writing within the context of GenAI technologies. These technologies, capable of generating human-like texts, impact a variety of societal contexts in the field of education. In response to the rapid technological advancements in this area, I have redesigned my research trajectory. This redesign, driven by the Complex Thinking research guiding questions, directly informed my new methodological path, illustrating the holographic approach, where each part of my research reflects and contains the complexities of the whole (see Figure 17).

Figure 17 – Complex Thinking: my research guiding questions



Source: created by the author based on Petraglia and Moraes (2022).

Following these questions guided the redesign of my method. The process required time, reflection, and alertness to new societal aspects influenced by the massive impact of GenAI technologies in the field of education shown on internet-based platforms. Consequently, I found it necessary to continue working with the Complex Thinking guiding questions to attain a clearer understanding of my new path (see Figure 18).

Figure 18 – My guiding questions

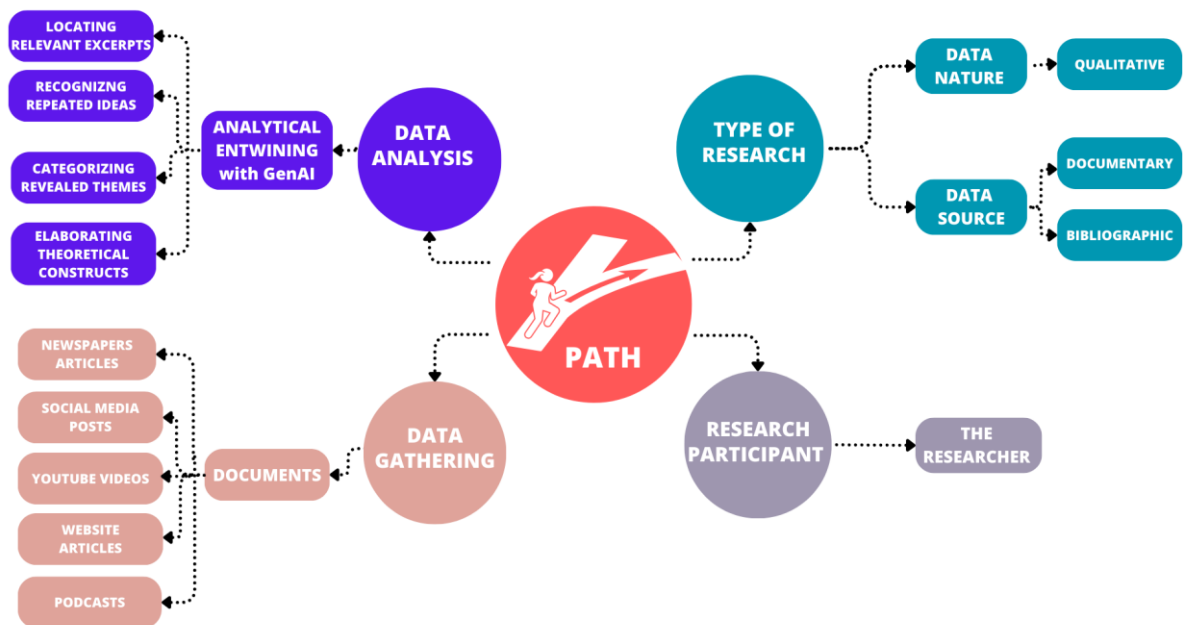


Source: created by the author based on Petraglia & Moraes (2022).

Within the complex perspective, theory acts like a cognitive blueprint that leaves lasting impressions, while the method requires strategy, initiative, invention, and artistry for effective implementation (Morin; Motta; Ciurana, 2003). There is a recursive relationship between method and theory: the method is derived from theory and, in turn, revitalizes the theory itself. A theory that possesses complexity can maintain its intricate nature only through constant intellectual recreation. Without continual innovation, such theories are at risk of degeneration into oversimplification. Left unattended, theories tend to become flattened, losing their multidimensionality and becoming static. From a complexity standpoint, theory is indistinguishable from method; both are essential components of complex knowledge.

In light of Complex Thinking, and following a deep engagement with the guiding questions of my research, the new design of my methodological path became more explicit (see Figure 19). This mind map summarizes the study in terms of four methodological aspects: type of research, research participant, data gathering, and data analysis (Gil, 2002).

Figure 19 – Designing my path



Source: created by the author (2023).

This visual representation shows the change of course in data source towards a documentary study motivated by the increasing presence of GenAI in the media, its rapid advancement, and its impacts on writing and education. The documents selected for this qualitative research are primarily sourced from internet-based platforms, with collection commencing at the start of my doctoral program in September 2020. The first relevant

document addressing the theme was from the British digital newspaper, The Guardian. This article, mentioned in the introduction (see Figure 6), appeared approximately three months after OpenAI released the algorithm GPT-3 on June 11, 2020. Although my doctoral program had not officially started at that time, I began examining the impacts of earlier versions like GPT-2. What naturally transpired over these years was the accumulation of media that addressed the object of my study. Using the note-taking tool Obsidian, I saved links to YouTube videos, podcasts, websites, and digital newspaper articles. Additionally, I archived social media posts using Instagram's saved feature.

I refer to these documents as 'screenshots of the reality I see'. They have become central to interpreting the interconnections among writing, education, and GenAI technologies, all of which are phenomena in their own right. Phenomena are seen as interactions representing experiences and perceptions of reality (Ravagnoli, 2017). Therefore, these documents can also be viewed as phenomena helping to apprehend the concept of writing by the adoption of GenAI in societal contexts in the field of education. Having detailed the methodological path, the subsequent subsection outlines the analytical method employed on the collected data.

2.5 Method of analysis

In this subsection, I present the method of analysis for this study, Analytical Entwining integrated with GenAI, adapted from Boa Sorte *et al.* (2023) and dos Santos, Boa Sorte & de Oliveira (forthcoming). First, I explain Analytical Entwining (Boa Sorte *et al.*, 2023), as it forms the foundation for this analytical method. Next, I detail the data analysis strategies developed and describe how I leveraged ChatGPT to engage with the research data.

Analytical Entwining (Boa Sorte *et al.*, 2023) has emerged from research carried out by members of the research group mentored by my advisor, Prof. Dr. Paulo Boa Sorte, Technologies, Education, and Applied Linguistics (TECLA), from the Federal University of Sergipe. This analytical perspective results from the interlacing between the theoretical-methodological contributions of Teacher Research (Freeman, 1998) and Coding Process (Auerbach; Silverstein, 2003). It addresses the need to expand the possibilities for instruments and techniques for data gathering in Education and Applied Linguistics research, particularly considering the potential of digital technologies, and more recently, AI.

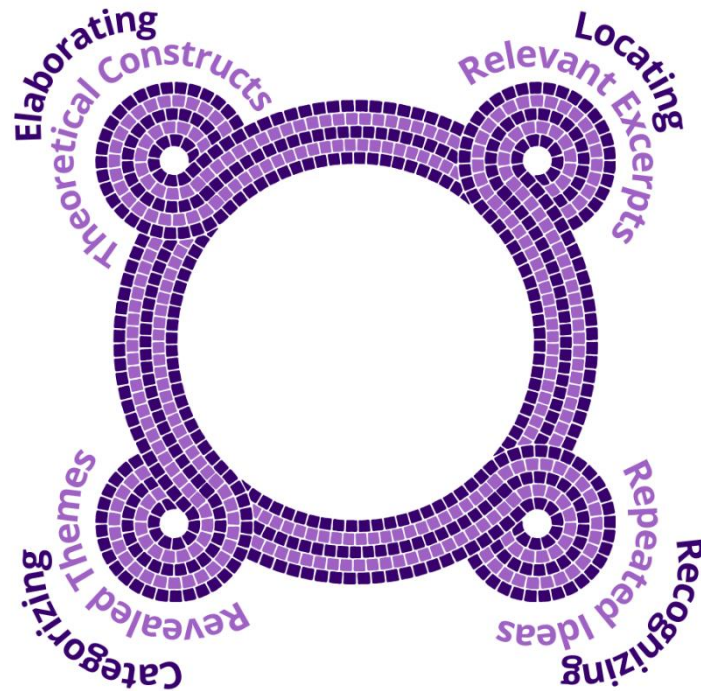
This method consists of four steps named analytical movements (see Figure 20). These movements serve as guiding stages that help researchers manage large datasets while consistently upholding ethical standards and scientific rigor. The method's flexible nature

allows for to-and-fro movements, enabling researchers to achieve study goals and respond to research questions as they engage with data. Simultaneously, Analytical Entwining permits researchers to reconsider and reshape their research trajectory in response to new insights and reflections. During the process, carrying out analysis and redesigning the path tend to generate anguish and uncertainty originating from data. Ultimately, this method positions the researcher at the core of the study, inherently interconnected with the object of investigation.

Given these considerations, it is discernible how selecting Analytical Entwining (Boa Sorte *et al.*, 2023) naturally integrates into the epistemological and methodological approach selected for this study. It properly aligns with Complex Thinking (Morin, 2015) through its engagement with the subject-object relationship, a key epistemological principle in research due to its methodological implications. Furthermore, this method of interpretation does not aim to obtain results perceived as singular and decontextualized truths whose conclusions seek to define a research object exhaustively. Conversely, it realizes the subject as “historically situated within a specific context, and their perspective emerging from social constructions” (Boa Sorte *et al.*, 2023, p. 26). It also agrees with the notion that knowledge is changeable and certainties are not permanent according to Complex Thinking (Petraglia; Moraes, 2022). Consequently, these are the reasons why I integrate Analytical Entwining into the conduct of my investigation.

To describe this analytical approach, I refer to its visual representation (see Figure 20). This image depicts, in a clockwise direction, the four to-and-fro movements intended to guide researchers while interpreting data: locating relevant excerpts, recognizing repeated ideas, categorizing revealed themes, and elaborating theoretical constructs (Boa Sorte *et al.*, 2023). The authors note that the choice of the term *movements* instead of *steps* is intended to highlight the absence of linearity when an analysis is being carried out, as shown in the illustration.

Figure 20 – Analytical Entwining



Source: Boa Sorte *et al.* (2023), my translation.

The analysis begins with the researcher “locating relevant excerpts” in each document, interview transcript, or any other data-gathering instruments. For the purposes of this research, I focus on documents, as they are the primary source of data for this study. Documents are stored in folders on a computer, although working with printed copies is also an option. During this initial movement, the investigator highlights passages that contain ideas significant to the research objectives or questions. This analytical movement involves decision-making, guided by questions such as: Does this excerpt relate to my research objectives? Does it help me understand the object of my study better? Does it clarify my research questions? Is this excerpt relevant even if I cannot identify the reason? This last question is important to remind researchers to either listen to the participants or be attentive to other meaningful aspects regarding the object of study.

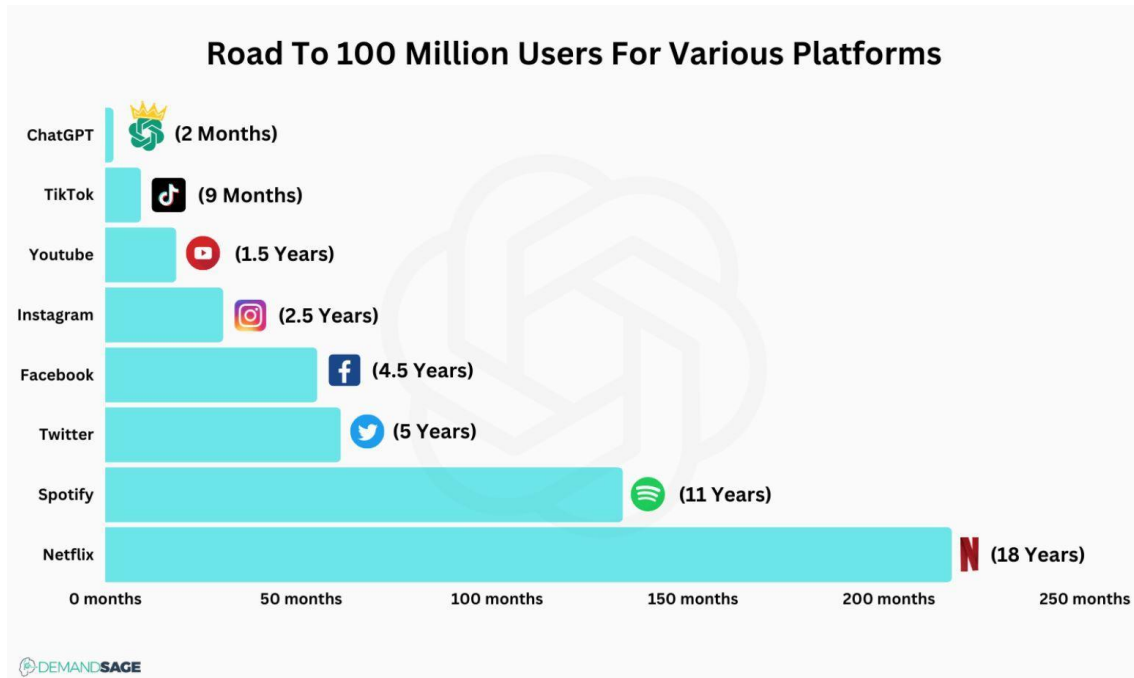
Following this, the researcher opens the file containing relevant excerpts from Document 1 and compiles a new file termed the ‘list of repeated ideas’ for that document. The researcher examines these selected relevant excerpts in detail, identifying passages similar to the initial relevant excerpt aiming at “recognizing repeated ideas”. These findings are then highlighted, copied, and consolidated into the repeated ideas file. This process is replicated for each document, forming the initial building blocks for developing a theoretical narrative.

The list of repeated ideas from all documents is organized into a single file, known as the ‘macro list of ideas’. This list serves as the foundation for the thematic organization of data. The movement, “categorizing revealed themes”, involves grouping recurring ideas into coherent categories. This third stage starts with an initial theme, with each theme representing a cluster of recurring ideas. The researcher identifies conceptual similarities among the repeated ideas, forming the basis of each theme. This basis is derived from both literature review and data analysis, as the researcher gains insight into each document. When naming themes, the researchers are advised to avoid jargon and prefer titles that clearly express the union of the repeated ideas for easy understanding.

Throughout the four to-and-fro analytical movements, the researcher continuously reflects on how each element relates to the research questions and objectives, while also considering significant outlier information from the documents. The researcher’s cognitive style determines the approach mostly described as a subjective and interpretive process since it does not impose strict rules for identifying relevance or grouping ideas. These are essential reminders for the conclusion of the analysis when the themes are grouped with the objective of “elaborating theoretical constructs”, an example of a Complex movement.

To exemplify the application of Analytical Entwinning, I analyze documents, including digital newspaper articles published after November 30, 2022, the release date of ChatGPT. The selection criteria for these documents include alignment with research goals and publications within the first two months post-release, a period chosen due to this AI chatbot’s unprecedented global impact, evidenced by reaching a user base of 100 million in record time (see Figure 21).

Figure 21 – ChatGPT: 100 million active users



Source: DemandSage (2023).

Considering these inclusion criteria, I begin the analysis by examining eight digital newspaper articles (see Table 1), identifiable through color-coded excerpts (see Tables 2 and 3). Prior to initiating the analytical movements, it is essential to have in mind the general and specific objectives to be achieved in the investigation. The probability of becoming entangled in the abundance of data is a concern that Freeman (1988) and Auerbach and Silverstein (2003) point out. Therefore, the general objective of my research is to apprehend the concept of the phenomenon of writing impacted by the adoption of GenAI in societal contexts in the field of education. Additionally, the specific objectives are to examine the approach to writing conveyed on internet-based platforms, particularly after the launch of ChatGPT; and to explore educational, pedagogical, and ethical issues related to the impact of AI-text generators, especially ChatGPT, raised on internet-based platforms.

Table 1 – Data: digital newspaper articles

Article Title/Author	Publication Date	Newspaper name
What is the AI chatbot phenomenon ChatGPT and could it replace humans? (Samantha Lock)	Dec. 5, 2022	The Guardian
TechScape: meet ChatGPT, the viral AI tool that may be a vision of our weird tech future (Alex Hern)	Dec. 6, 2022	The Guardian
The college essay is dead (Stephen Marche)	Dec. 6, 2022	The Atlantic
ChatGPT: new AI chatbot has everyone talking to it (Chris Vallance)	Dec. 7, 2022	BBC
The end of high-school English (Daniel Herman)	Dec. 9, 2022	The Atlantic
AI-assisted plagiarism? ChatGPT bot says it has an answer for that (Alex Hern)	Dec. 31, 2022	The Guardian
Don't ban ChatGPT in schools. Teach with it. (Kevin Roose)	Jan. 12, 2023	The New York Times
ChatGPT: student builds app to sniff out AI-written essays (Nadine Yousif)	Jan. 13, 2023	BBC News

Source: created by the author (2023).

I start the analysis by the initial contact with the data when “locating relevant excerpts”, considering the objectives of this research. I number each of my documents and begin the second analytical movement by choosing the idea number one and continue “recognizing repeated ideas” both in document one and in the other seven documents. The idea number one, “It is an AI chatbot phenomenon [...]” guides the identification of other terms that express the content of the selected initial idea (see Table 2).

Table 2 – Repeated ideas: initial theme

“It is an AI chatbot phenomenon [...] The tool has impressed experts [...]” [...] AI chatbot capable of understanding natural human language and generating impressively detailed human-like written text.” “OpenAI’s new chatbot isn’t a novelty. It’s already powerful and useful – and could radically change the way we write online [...]” “OpenAI released an advanced chatbot named ChatGPT that has spawned a new wave of [...] It is frankly amazing.” “The results have impressed many who’ve tried out the chatbot.” “ChatGPT is a freakishly capable tool that landed in their midst with no warning, and it performs reasonably well across a wide variety of tasks and academic subjects.” “This technology is only going to get better and better, AI is here to stay. This is the future,” The popularity of ChatGPT since its launch has been met with alarm, including from some US schools who have blocked it on their servers in a bid to prevent students from cheating.” “The arrival of OpenAI’s ChatGPT, a program that generates sophisticated text in response to any prompt you can imagine, may signal the end of writing assignments altogether—and maybe even the end of writing as a gatekeeper, a metric for intelligence, a teachable skill.” Theme 1: <i>Writing is impacted by GenAI technologies, especially ChatGPT.</i>
--

Source: created by the author (2023).

The repeated ideas in Table 2, expressed by words highlighted in bold and represented by the excerpts: “[...] AI chatbot phenomenon”; “[...] It’s already powerful and useful – and could radically change the way we write online [...]”; “ChatGPT is a freakishly capable tool that landed in their midst with no warning [...]”; “[...]AI is here to stay. This is the future [...]” address ChatGPT’s capabilities to generate texts and its reactions in societal contexts. By recognizing these repeated ideas, I categorized the first theme, entitled *writing is impacted by GenAI technologies, especially ChatGPT*. The analytical movements of identifying a second repeated idea continues (see Table 3).

Table 3 – Repeated ideas: second theme

“ChatGPT is a prototype dialogue-based AI chatbot capable of understanding natural human language and generating impressively detailed human-like written text.” “The dialogue format makes it possible for ChatGPT to answer follow-up questions.” “[...] it is capable of providing descriptions, answers and solutions to complex questions.” “Real-world applications could include generating content for websites, answering customer inquiries, providing recommendations as well as creating automated chatbots.” “It’s a tool that is, already [...] useful. [...] it can answer questions that would be wildly frustrating to Google, like explaining why a particular joke is funny [...]. Use it like a text generator, and it can create reams of text that are clear, plausible and generally bland [...]. You can bounce ideas off it, request rephrasings, summaries or expansions, and then finesse the work in the finished project.” “[...] an upgrade to GPT-3 that allows for complex rhyming poetry.” “[...] might be able to write a passable job application, school essay or grant application [...]” “[...] a new AI chatbot that can write convincing essays –clear and coherent responses written in natural English [...] can provide convincing human-sounding answers to exam questions, The use of AI tools to generate writing that can be passed off as one’s own [...]” “[...] that is capable of writing cogent essays, solving science and math problems and producing working computer code... Students are using it to write their assignments, passing off AI-generated essays and problem sets as their own.” “It performs reasonably well across a wide variety of tasks and academic subjects.” “ChatGPT: Student builds app to sniff out AI-written essays [...]” “Let me be candid (with apologies to all of my current and former students): What GPT can produce right now is better than the large majority of writing seen by your average teacher or professor It also managed to compose a convincing 400-word “friendly” cover letter for an application to be a manager at Starbucks.”
Theme 2: <i>Writing can be done by a machine.</i>

Source: created by the author (2023).

The repeated ideas in Table 3, expressed by words highlighted in bold and also represented by the following excerpts: “[...] One academic... described it as writing with the style and knowledge of a smart 13-year-old... the system also makes a fantastic partner [...]follow”; “Silicon Valley firm insists its new text generator, which writes human-sounding essays [...]”; “[...] a free online chatbot that can expertly write almost anything, from English essays and news articles, to meal plans and computer code [...]” exemplify various possible uses

of ChatGPT to generate human-like texts in societal contexts, particularly in education contexts. By recognizing these repeated ideas, I categorized the second theme, named *writing can be done by a machine*.

The third theme revealed in the initial moments of the analysis was categorized as *writer's block is over*. Since these three themes established a connection, I propose the first theoretical construct: WRITING CAN BE DONE BY “ANY” “ONE”. In addition, four other themes were revealed. However, up to this moment in my research path, I only established a connection between two themes: *writing essays serves the purpose of assessment in education*; *writing essays has become easier and faster*, then I elaborate the second theoretical construct: WRITING IS CORE TO ASSESSMENT IN EDUCATION (see Table 4).

Table 4 – Theoretical constructs and themes

WRITING CAN BE DONE BY “ANY” “ONE”
Theme 1: <i>Writing is impacted by GenAI technologies, especially ChatGPT</i>
Theme 2: <i>Writing can be done by a machine</i>
Theme 3: <i>Writer's block is over</i>
WRITING IS CORE TO ASSESSMENT IN EDUCATION
Theme 4: <i>Writing essays serves the purpose of assessment in education</i>
Theme 5: <i>Writing essays has become easier and faster</i>

Source: created by the author (2023).

Following the conventions by Auerbach and Silverstein (2003), theoretical constructs are written in capital letters, revealed themes are written in italics, and repeated ideas are the terms between quotation marks. In this example, five thematic categories were revealed and organized into two theoretical constructs. Ultimately, these constructs are discussed in light of Complex Thinking along with the theoretical bases forming the theoretical narrative.

Conducting research through the lens of Complex Thinking and adopting Analytical Entwinning as a method of data interpretation enables researchers to address epistemological and methodological implications that arise from the undeniable subject-object interconnectedness. Moreover, it allows for the expression of a researcher who acknowledges themselves as being historically and contextually situated with perspectives shaped by societal constructs (Boa Sorte *et al.*, 2023). This interpretive approach rejects the idea of fixed truths, and understands

knowledge and complex systems as mutable and random implying strategies play a crucial role in a research journey (Morin, 2015; Petraglia; Moraes, 2022).

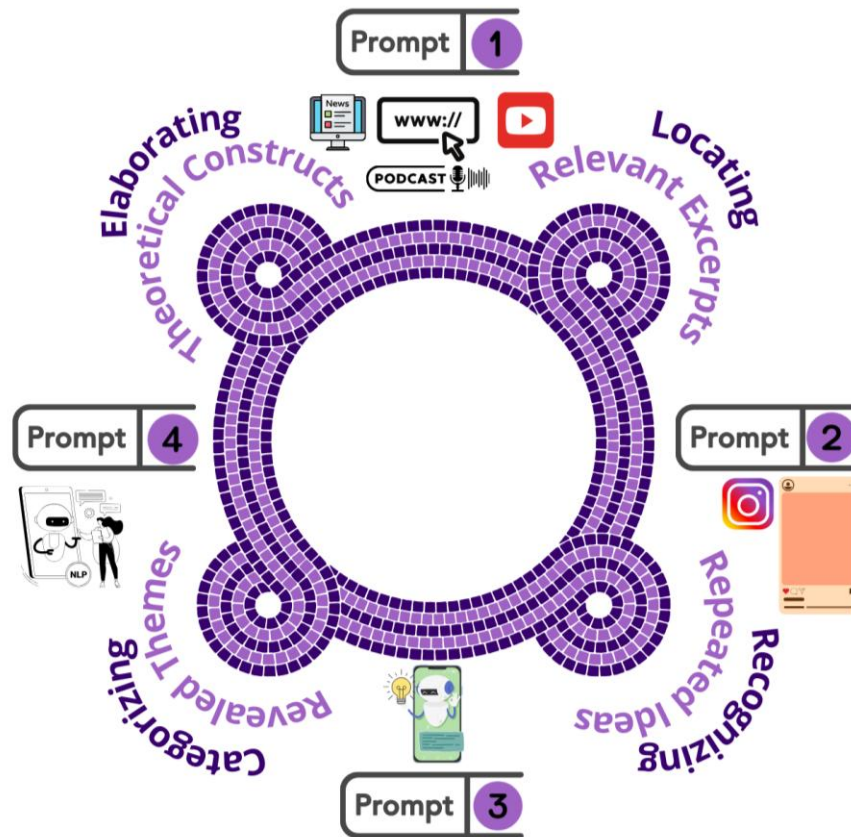
Through the lens of Complex Thinking, I describe “screenshots of the reality I see” as a strategy in my research path. This term refers to the gathered documents used to interpret the interconnections among the phenomena of writing, education, GenAI technologies, and societal contexts represented by the phenomena of digital newspapers and website articles, social media posts, YouTube videos, and podcasts. This term highlights how perceptions of reality are subjective and multifaceted, including personal experiences, societal constructs, and cognitive biases. Using the metaphor “screenshots” suggests that an individual’s perception of reality captures a momentary, partial view, and is visible at a specific time. I understand this aligns well with the principles of Complex Thinking because it acknowledges that our understanding of reality is always limited and constructed from specific viewpoints.

Furthermore, among the numerous documents I collected over the four years of this investigation, 60 were selected to be analyzed. Considering the abundance of data gathered, which is a major concern for researchers (Freeman, 1988; Auerbach; Silverstein, 2003), I propose integrating GenAI technology into the Analytical Entwining movements. This integration serves as the second strategy to engage with data in my research journey.

Building on this, incorporating a GenAI platform represents a strategic approach to enhance data interpretation, leveraging the capabilities of the ChatGPT/GPT-4 model (OpenAI, 2023c). My collaboration with ChatGPT facilitated the execution of the four analytical movements across two distinct human-machine interactions. The first interaction was designed to reach specific objective No. 1: to examine the approach to writing conveyed on internet-based platforms, particularly after the launch of ChatGPT. The second interaction aimed to explore educational, pedagogical, and ethical issues related to the impact of AI-text generators, especially ChatGPT, raised on internet-based platforms. In both interactions, ChatGPT generated theoretical constructs, assisting in meeting the general objective of this research: to apprehend the concept of the phenomenon of writing impacted by the adoption of GenAI in societal contexts in the field of education.

I now introduce Analytical Entwining integrated with GenAI (adapted from Boa Sorte *et al.*, 2023; dos Santos; Boa Sorte; de Oliveira, forthcoming). This method of analysis requires careful prompt engineering to maximize the potential of the GenAI platform. I designed four specific prompts to conduct the analysis, each tailored to address individual characteristics of the analytical movements required for this method (see Figure 22).

Figure 22 – Analytical Entwining Integrated with GenAI

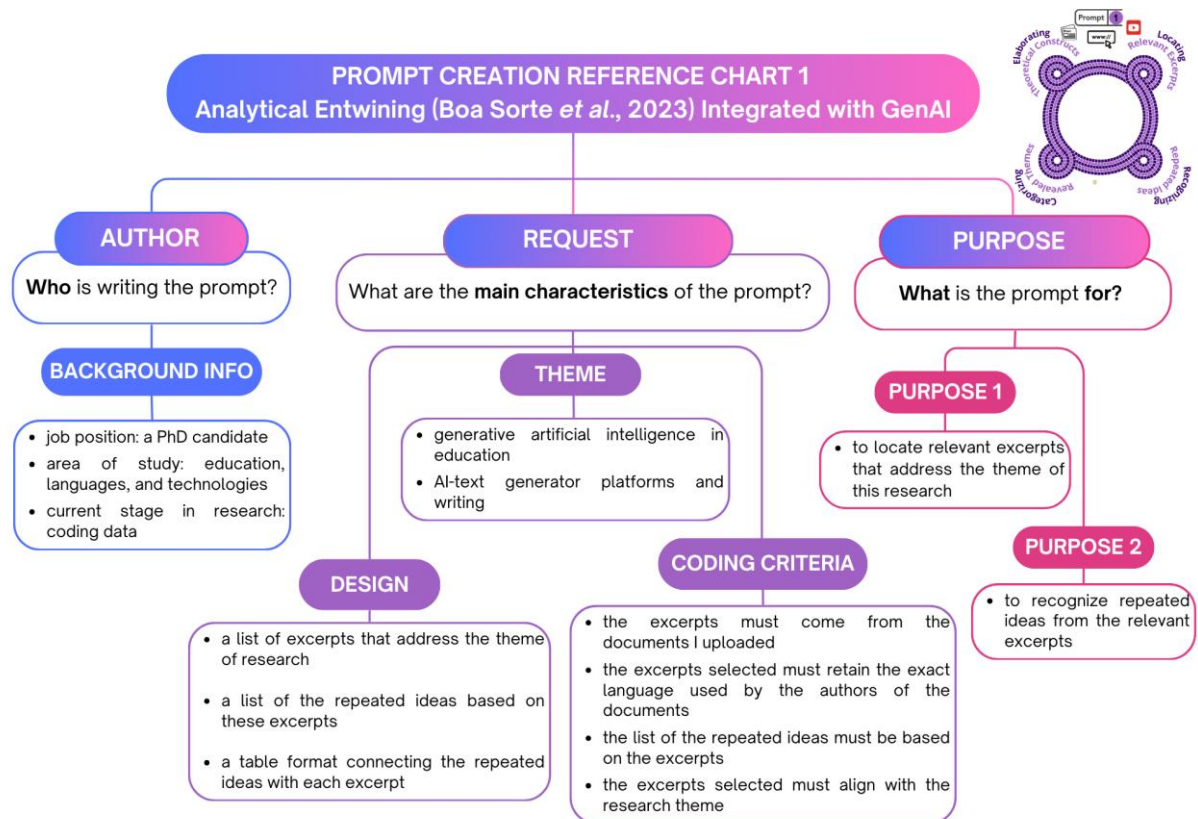


Source: created by the author based on Boa Sorte *et al.* (2023).

Unlike data analysis performed individually by a human, ChatGPT can concurrently process up to ten documents. This LLM is also capable of executing the first two analytical movements simultaneously. Within the framework of Analytical Entwining integrated with GenAI, the analysis begins with ChatGPT “locating relevant excerpts” in each document and “recognizing repeated ideas” across all the documents uploaded by the researcher. This initial process is driven by a single prompt provided by the researcher at the start of the collaboration with ChatGPT. Prompt No. 1, originally intended for analyzing textual documents, proved inadequate for social media posts. Consequently, prompt No. 2 was specifically designed to code documents saved as images and also to execute the first two movements. Once repeated ideas have been recognized across all document types, prompt No. 3 is employed to organize the “macro list of ideas”, laying the groundwork for the theme generation, and “categorizing revealed themes”. Lastly, prompt No. 4 delivers the essential commands enabling ChatGPT to establish connections among the “revealed themes” and finalize the analysis by “elaborating theoretical constructs”.

For this purpose, I utilized the Prompt Creation Reference Chart, which outlines three key elements crucial for constructing effective prompts: “(1) the prompt’s author: background information, (2) the main characteristics of the request: design, target audience, and theme, (3) and the purpose of the prompt: what the prompt is for, what the user wants to achieve” (dos Santos; Boa Sorte; de Oliveira, forthcoming). This Reference Chart is a principle to promote the creation of well-structured initial prompts. As outlined by this principle, the request component — the second element — can be customized according to the specific context, thus enabling GenAI users to craft their prompts more effectively. To align with the research requirements, I modified this component by replacing Target Audience with Coding Criteria. This alteration enables researchers to incorporate specific coding criteria essential for conducting data analysis (see Figure 23).

Figure 23 – Prompt Creation Reference Chart 1



Source: adapted from dos Santos, Boa Sorte & de Oliveira (Forthcoming).

For ethical considerations, the formulation of prompt No. 1 was developed without disclosing the research objectives to ChatGPT, guided by the Prompt Creation Reference Chart 1. This first prompt, as detailed in Table 5, serves as the foundational basis for the subsequent three prompts adopted in Analytical Entwining integrated with GenAI.

Table 5 – Visualizing Prompt No. 1

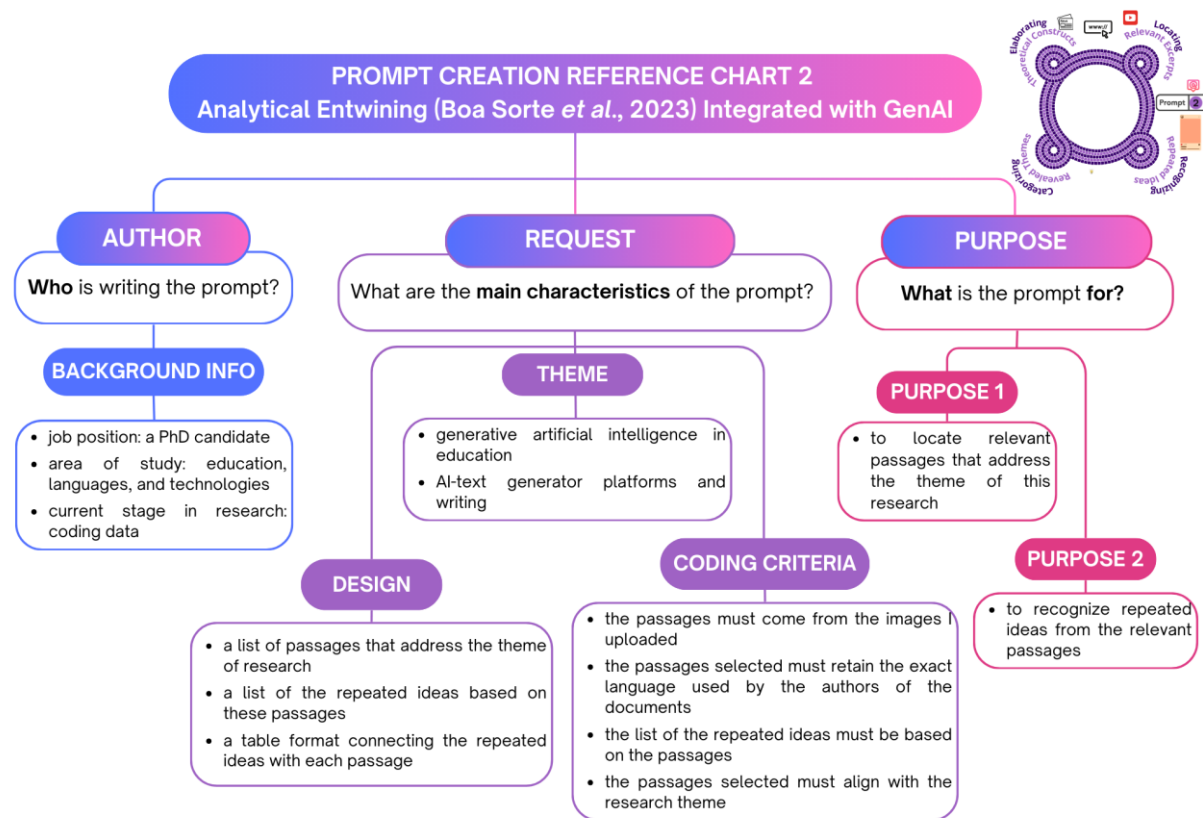
I am a PhD candidate researching in the area of education, languages, and technologies. I am currently focusing on coding the collected data. Generate a list of excerpts that address the theme of research, a list of the repeated ideas based on these excerpts, and a table format, connecting the repeated ideas with each excerpt. The research focuses on generative artificial intelligence in education, AI-text generator platforms, and writing. This task needs to follow some criteria: the excerpts must come from the documents I uploaded, the excerpts selected must retain the exact language used by the authors of the documents, the list of the repeated ideas must be based on the excerpts, and the excerpts selected must align with the research theme. Generate these lists bearing in mind the purposes: to locate relevant excerpts that address the theme of this research, and to recognize repeated ideas from those excerpts.
AUTHOR (WHO): BACKGROUND INFORMATION
REQUEST (MAIN CHARACTERISTICS): DESIGN – THEME – CODING CRITERIA
PURPOSE (WHAT FOR): PURPOSE 1 + PURPOSE 2

Source: created by the author (2023).

It is important to note that the background information — represented as the “author” component — and the “theme”, which forms part of the “request” component, remain the same across the four prompts created for this data analysis. The choice of language, which informs the “theme” and the other main characteristics of the prompt, is critical. It provides the LLM with sufficient detailed information, enabling the GenAI platform to generate the required outputs without having to inform the research objectives.

To demonstrate the significance of language choice in prompt engineering, I revisit the rationale for customizing a second prompt that enables ChatGPT to execute the analytical movements of “locating relevant excerpts” and “recognizing repeated ideas”. During tests with ChatGPT, it became apparent that prompt No. 1 was unable to process image documents due to the use of the term “excerpt”. Consequently, for image data, the term “passage” was employed. This led to the refinement of the initial prompt, in accordance with Prompt Creation Reference Chart 1, resulting in the development of prompt No. 2 (see Figure 24).

Figure 24 – Prompt Creation Reference Chart 2



Source: adapted from dos Santos, Boa Sorte & de Oliveira (Forthcoming).

Continuing as a component of the “request” element, the “design” is distinguished as a key feature of the prompt, encompassing the structuring of text, visuals, and additional forms. The design delineates the manner in which ChatGPT is expected to arrange the format of the response. This component is essential to specify how ChatGPT should configure the layout of the output. The layouts of this method of analysis include lists and tables. The “design” component of prompts No. 1 and No. 2, as illustrated in Tables 5 and 6, requests ChatGPT to deliver a ‘list of repeated ideas’ based on a list of ‘relevant information’ that addresses the outlined theme of research and a table connecting the repeated ideas with this selected ‘relevant information’.

Table 6 – Visualizing Prompt No. 2

I am a PhD candidate researching in the area of education, languages, and technologies. I am currently focusing on coding the collected data. Generate a list of passages that address the theme of research, a list of the repeated ideas based on these passages, and a table format, connecting the repeated ideas with each passage. The research focuses on generative artificial intelligence in education, AI-text generator platforms, and writing. This task needs to follow some criteria: the passages must come from the images I uploaded, the passages selected must retain the exact language used by the authors of the documents, the list of the repeated ideas must be based on the passages, and the passages selected must align with the research theme. Generate these lists bearing in mind the purposes: to locate relevant passages that address the theme of this research, and to recognize repeated ideas from those passages.
AUTHOR (WHO): BACKGROUND INFORMATION
REQUEST (MAIN CHARACTERISTICS): DESIGN – THEME – CODING CRITERIA
PURPOSE (WHAT FOR): PURPOSE 1 + PURPOSE 2

Source: created by the author (2023).

The “design” element influences the perception and comprehension of information. Well-designed text layouts enhance communication effectiveness by simplifying the analysis process. These “design” principles were integral during my collaboration with ChatGPT. During the first two movements of analysis, ChatGPT successfully “located relevant information” across various document types and “recognized repeated ideas”. The results were organized into two lists and one table, illustrating the connections between them as specified in the “design” requirements of prompts No. 1 and No. 2, as demonstrated in Table 7.

Table 7 – Visualizing Output Text Document 4C

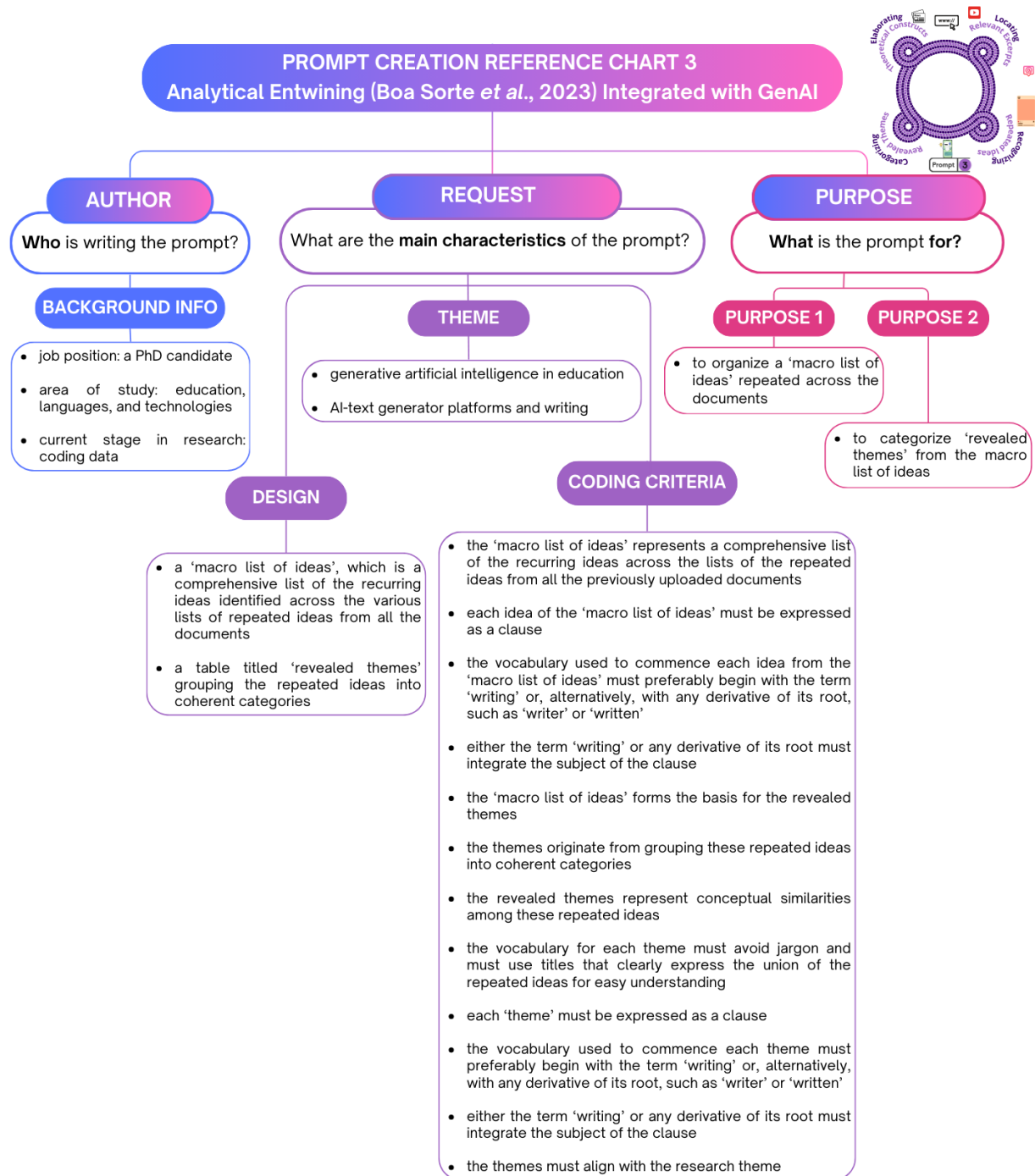
ChatGPT	
From the document titled "Should we let students use ChatGPT? TED Talk," here's a structured analysis for your research:	
Excerpts Addressing the Theme Excerpt 1: "This TED Talk discusses the integration of AI tools like ChatGPT in educational settings and debates whether their use should be encouraged or restricted."(#4C Should we let stude...) Excerpt 2: "The presenter argues that while AI can significantly enhance learning, it also raises concerns about academic integrity and the development of critical thinking skills."(#4C Should we let stude...) Excerpt 3: "Examples are given of schools that have successfully integrated ChatGPT to improve engagement and personalize learning, highlighting positive outcomes."(#4C Should we let stude...) Excerpt 4: "Concerns are also voiced about students becoming overly reliant on AI for homework and assignments, potentially hindering their learning process."(#4C Should we let stude...) Excerpt 5: "The talk concludes with a call for educational institutions to develop clear guidelines and policies that maximize the benefits of AI while mitigating its risks."(#4C Should we let stude...)	
Repeated Ideas Based on Excerpts AI Integration in Education: Discusses the incorporation of AI tools like ChatGPT in educational practices, focusing on both the positive impacts and challenges. Academic Integrity and Dependency Concerns: Emphasizes the potential risks of AI in education, particularly in terms of academic integrity and student dependency Policy Development for AI Use: Advocates for the development of structured policies and guidelines to manage the use of AI in educational settings effectively.	
Table Connecting Repeated Ideas with Excerpts	
Repeated Idea	Connected Excerpt
AI Integration in Education	Excerpt 1, 3
Academic Integrity and Dependency Concerns	Excerpt 2, 4
Policy Development for AI Use	Excerpt 5
This analysis provides insights into the complex dynamics of using AI like ChatGPT in educational contexts, exploring the balance between leveraging technological advancements for enhanced learning and ensuring that students remain the primary agents in their educational journeys.	

Source: created by the author in collaboration with ChatGPT (OpenAI, 2023c).

This table displays the responses of the ChatGPT/GPT-4 model (OpenAI, 2023c) to prompt No. 1 after completing the first two analytical movements on text document 4C, a YouTube video transcript. Initially, the model generates a list of five excerpts that address the outlined theme of this study. Then, it produces a second list including the three ideas recurring within these excerpts. The second analytical movement concludes with a table where each row connects a thematic idea with its corresponding excerpts from the document.

Once all document types are individually coded, the analysis can proceed to the third analytical movement: “categorizing revealed themes”. This phase involves grouping recurring ideas into coherent categories. Such thematic organization of data is supported by the “macro list of ideas”, which not only facilitates this process but is also indispensable for laying the foundational groundwork necessary for generating themes. Although this procedure is part of the “recognizing repeated ideas” movement, it cannot be executed in isolation during prompts No. 1 and No. 2. This is because it involves compiling a list of repeated ideas identified across all document types, texts and images. Consequently, the organization of a “macro list of ideas” is incorporated into the “design” element in prompt No. 3 as specified in the Prompt Creation Reference Chart 3 (see Figure 25).

Figure 25 – Prompt Creation Reference Chart 3



Source: adapted from dos Santos, Boa Sorte & de Oliveira (Forthcoming).

The final key component of the “design” element tailored for the Analytical Entwining integrated with GenAI is the “coding criteria”. Prompt Creation Reference Chart 3 outlines how ChatGPT should implement the “categorizing revealed themes” movement in accordance with Analytical Entwining, a foundation for the method of analysis. This chart also specifies the language to optimize responses from the LLM. Language choice in prompt engineering

represents a major and challenging requirement, as demonstrated in prompt No. 3 (see Table 8).

Table 8 – Visualizing Prompt No. 3

I am a PhD candidate researching in the area of education, languages, and technologies. I am currently focusing on coding the collected data. Generate a ‘macro list of ideas’, a comprehensive list of the recurring ideas identified across the various lists of repeated ideas from all the documents, and a table titled ‘revealed themes’ grouping the repeated ideas into coherent categories. The research focuses on generative artificial intelligence in education, AI-text generator platforms, and writing. This task needs to follow some criteria: the ‘macro list of ideas’ represents a comprehensive list of the recurring ideas across the lists of the repeated ideas from all the previously uploaded documents, each idea of the ‘macro list of ideas’ must be expressed as a clause, the vocabulary used to commence each idea from the ‘macro list of ideas’ must preferably begin with the term ‘writing’ or, alternatively, with any derivative of its root, such as ‘writer’ or ‘written’, either the term ‘writing’ or any derivative of its root must integrate the subject of the clause, the ‘macro list of ideas’ forms the basis for the revealed themes, the themes originate from grouping these repeated ideas into coherent categories, the revealed themes represent conceptual similarities among these repeated ideas, the vocabulary for each theme must avoid jargon and must use titles that clearly express the union of the repeated ideas for easy understanding, each ‘theme’ must be expressed as a clause, the vocabulary used to commence each theme must preferably begin with the term ‘writing’ or, alternatively, with any derivative of its root, such as ‘writer’ or ‘written’, either the term ‘writing’ or any derivative of its root must integrate the subject of the clause, and the themes must align with the research theme. Generate these lists bearing in mind the purposes: to organize a ‘macro list of ideas’ repeated across the documents, and to categorize ‘revealed themes’ from the macro list of ideas.
AUTHOR (WHO): BACKGROUND INFORMATION
REQUEST (MAIN CHARACTERISTICS): DESIGN – THEME – CODING CRITERIA
PURPOSE (WHAT FOR): PURPOSE 1 + PURPOSE 2

Source: created by the author (2023).

The guidelines are developed to help structure and articulate ideas and themes derived from previously analyzed documents. They emphasize the consistent employment of specific vocabulary, especially derivatives of “writing”, to initiate each idea and theme. Furthermore, the guidelines advocate for the use of clear, jargon-free language and ensure that these themes align directly with the main research theme, promoting coherence and ease of comprehension. After collaborating with ChatGPT using prompt No. 3, the model successfully categorized four themes. The results were organized into two lists and one table, illustrating the connections between the “revealed themes” and the “macro list of ideas” (see Table 9).

Table 9 – Visualizing Output - Prompt No. 3 - Specific Objective 1

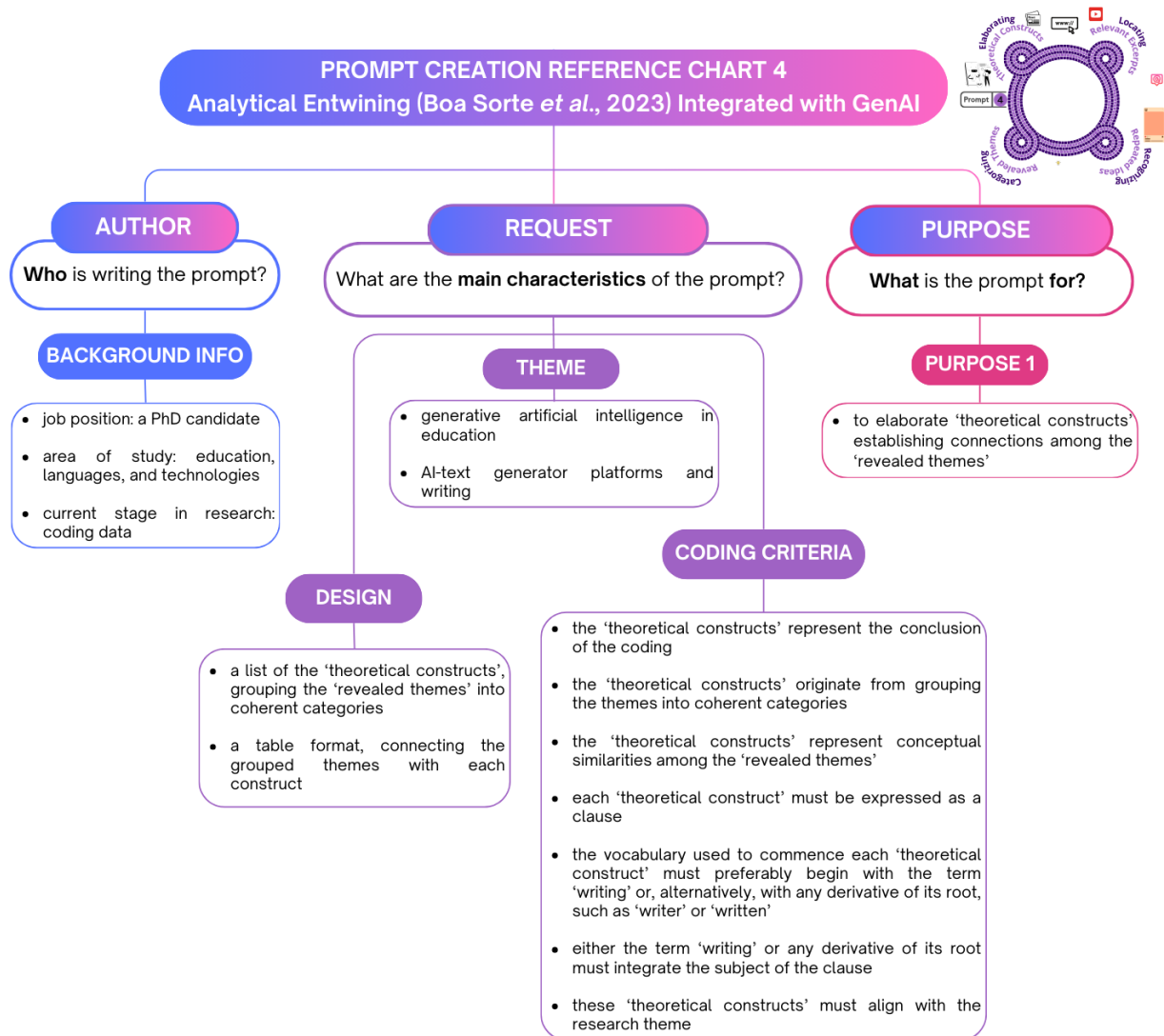
ChatGPT	
To align with your research on generative artificial intelligence in education, AI-text generator platforms, and writing, I will create a ‘macro list of ideas’ and group these ideas into ‘revealed themes’. Each entry will be crafted as a clause with ‘writing’ or its derivatives as the subject, adhering to the specified criteria to ensure clarity and relevance to the overarching research theme.	
Macro List of Ideas	
Writing processes are being expedited by AI's ability to automate routine tasks. Writing's creative dimensions are expanded by AI through offering novel suggestions and ideas. Writing integrity is being safeguarded by AI tools that ensure ethical practices such as avoiding plagiarism. Writing tools are becoming more interactive and accessible due to AI's integration. Writing's appeal and engagement are enhanced through AI-facilitated community platforms that foster collaboration. Writing education is evolving as AI provides personalized learning experiences. Writing's global reach is extended by AI's multilingual capabilities, making content accessible across language barriers.	
Revealed Themes	
Writing is enhanced through AI by expediting processes and expanding creative dimensions. Connected Ideas: Writing processes are being expedited by AI; Writing's creative dimensions are expanded by AI. Writing integrity is safeguarded by AI tools ensuring ethical practices. Connected Ideas: Writing integrity is being safeguarded by AI tools. Writing becomes more interactive and accessible through AI technologies. Connected Ideas: Writing tools are becoming more interactive; Writing's appeal is enhanced through AI-facilitated community platforms. Writing education evolves with AI providing personalized learning experiences and extending global reach. Connected Ideas: Writing education is evolving as AI provides personalized experiences; Writing's global reach is extended by AI's capabilities.	
Table Connecting Macro Ideas with Revealed Themes	
Macro Idea	Revealed Theme
Writing processes are being expedited by AI	Writing is enhanced through AI by expediting processes and expanding creative dimensions.
Writing's creative dimensions are expanded by AI	Writing is enhanced through AI by expediting processes and expanding creative dimensions.
Writing integrity is being safeguarded by AI tools	Writing integrity is safeguarded by AI tools ensuring ethical practices.
Writing tools are becoming more interactive	Writing becomes more interactive and accessible through AI technologies.

Writing's appeal is enhanced through AI platforms	Writing becomes more interactive and accessible through AI technologies.
Writing education is evolving with AI	Writing education evolves with AI providing personalized learning experiences and extending global reach.
Writing's global reach is extended by AI	Writing education evolves with AI providing personalized learning experiences and extending global reach.
These themes provide a structured overview of how AI impacts writing, aligning with your research focus on generative AI in education, AI-text generator platforms, and writing. This approach ensures clarity and cohesiveness in presenting your findings.	

Source: created by the author in collaboration with ChatGPT (OpenAI, 2023c).

This table presents the responses of the ChatGPT/GPT-4o model (OpenAI, 2023c) to prompt No. 3, after analyzing 30 documents selected to achieve specific objective 1. The model generates a 'macro list' of seven recurring ideas from these text and image documents. Following this, ChatGPT categorized these ideas into four themes, listing them and identifying each connected idea. The third analytical movement culminates in a table where each row connects a revealed theme with its corresponding macro ideas from the documents. My collaboration with ChatGPT concludes in the fourth movement: "elaborating theoretical constructs". In this phase, ChatGPT connects the "revealed themes" and generates these constructs via prompt No. 4, as guided by Prompt Creation Reference Chart 4 (see Figure 26).

Figure 26 – Prompt Creation Reference Chart 4



Source: adapted from dos Santos, Boa Sorte & de Oliveira (Forthcoming).

With Prompt Creation Reference Chart 4, I present the final key element of prompt engineering in Analytical Entwining integrated with GenAI. This component refers to the “purpose” of the prompt, which details “what the prompt is for” and “what the user wants to achieve”; note that this may vary in number. In this study, all the “purposes” inform each analytical movement in every prompt and are described using consistent terminology that matches the analytical movements, as demonstrated in prompt No. 4 (see Table 10).

Table 10 – Visualizing Prompt No. 4

I am a PhD candidate researching in the area of education, languages, and technologies. I am currently focusing on coding the collected data. Generate a list of the ‘theoretical constructs’, grouping the ‘revealed themes’ into coherent categories and a table format, connecting the grouped themes with each construct. The research focuses on generative artificial intelligence in education, AI-text generator platforms, and writing. This task needs to follow some criteria: the ‘theoretical constructs’ represent the conclusion of the coding, the ‘theoretical constructs’ originate from grouping the themes into coherent categories, the ‘theoretical constructs’ represent conceptual similarities among the ‘revealed themes’, each ‘theoretical construct’ must be expressed as a clause, the vocabulary used to commence each ‘theoretical construct’ must preferably begin with the term ‘writing’ or, alternatively, with any derivative of its root, such as ‘writer’ or ‘written’, either the term ‘writing’ or any derivative of its root must integrate the subject of the clause, and these ‘theoretical constructs’ must align with the research theme. Generate these lists bearing in mind the purpose: to elaborate ‘theoretical constructs’ establishing connections among the ‘revealed themes’.
AUTHOR (WHO): BACKGROUND INFORMATION
REQUEST (MAIN CHARACTERISTICS): DESIGN – THEME – CODING CRITERIA
PURPOSE (WHAT FOR): PURPOSE 1 + PURPOSE 2

Source: created by the author (2023).

Prompt No. 4 also exemplifies the challenges and importance of language choice in “coding criteria”, as previously discussed in prompt No. 3. The guidelines outline methods for structuring theoretical constructs that summarize research findings. They highlight the consistent use of specific terminology related to “writing” to initiate each construct and require that these constructs be clearly phrased and aligned with the main research theme. The constructs themselves are developed by grouping related themes, thus emphasizing their conceptual links, as demonstrated in Table 11.

Table 11 – Visualizing Output - Prompt No. 4 - Specific Objective 1

ChatGPT To create theoretical constructs that encapsulate the revealed themes from your research, we will group the themes into coherent categories, ensuring each construct starts with "writing" or its derivatives as the subject. These constructs will summarize the findings and establish clear connections among the themes, aligning with your research focus on generative artificial intelligence in education, AI-text generator platforms, and writing.
Revealed Themes Recap 1. Writing is enhanced through AI by expediting processes and expanding creative dimensions. 2. Writing integrity is safeguarded by AI tools ensuring ethical practices. 3. Writing becomes more interactive and accessible through AI technologies. 4. Writing education evolves with AI providing personalized learning experiences and extending global reach.

Theoretical Constructs

1. **Writing is revolutionized by AI through enhancement and accessibility.**
 - **Grouped Themes:** Writing is enhanced through AI by expediting processes and expanding creative dimensions; Writing becomes more interactive and accessible through AI technologies.
 - **Description:** This construct combines the themes of enhancement and accessibility, highlighting how AI transforms the writing process by increasing efficiency, creativity, and user engagement.
2. **Writing integrity is maintained through AI-driven ethical safeguards.**
 - **Grouped Themes:** Writing integrity is safeguarded by AI tools ensuring ethical practices.
 - **Description:** This construct focuses on the ethical aspects of AI in writing, emphasizing the role of AI tools in preserving the integrity and authenticity of written content.
3. **Writing education is transformed by AI through personalization and global reach.**
 - **Grouped Themes:** Writing education evolves with AI providing personalized learning experiences and extending global reach.
 - **Description:** This construct addresses the impact of AI on education, particularly how AI facilitates personalized learning and broadens the accessibility of educational content across languages and regions.

Table Connecting Grouped Themes with Theoretical Constructs

Theoretical Construct	Grouped Themes
Writing is revolutionized by AI through enhancement and accessibility.	Writing is enhanced through AI by expediting processes and expanding creative dimensions; Writing becomes more interactive and accessible through AI technologies.
Writing integrity is maintained through AI-driven ethical safeguards.	Writing integrity is safeguarded by AI tools ensuring ethical practices.
Writing education is transformed by AI through personalization and global reach.	Writing education evolves with AI providing personalized learning experiences and extending global reach.

Source: created by the author in collaboration with ChatGPT (OpenAI, 2023c).

This final table displays the responses of the ChatGPT/GPT-4o model (OpenAI, 2023c) to prompt No. 4, following the completion of the fourth analytical movement, “elaborating theoretical constructs”. Initially, the model revisits the “revealed themes”. Although not required by the “design” element of Prompt Creation Reference Chart 4, this repetition aids the researcher in monitoring the process. Subsequently, the model generates a list of three theoretical constructs, specifying which themes were grouped together to form each construct and providing a brief description of each. The last analytical movement concludes with a table where each row links a theoretical construct to its corresponding revealed themes from the documents.

In studies in which the research data contains only one document type, the researcher may choose either prompt No. 1 for text documents or prompt No. 2 for image documents. This choice is based on the fact that both prompts encompass the initial and subsequent analytical movements of Analytical Entwining integrated with GenAI.

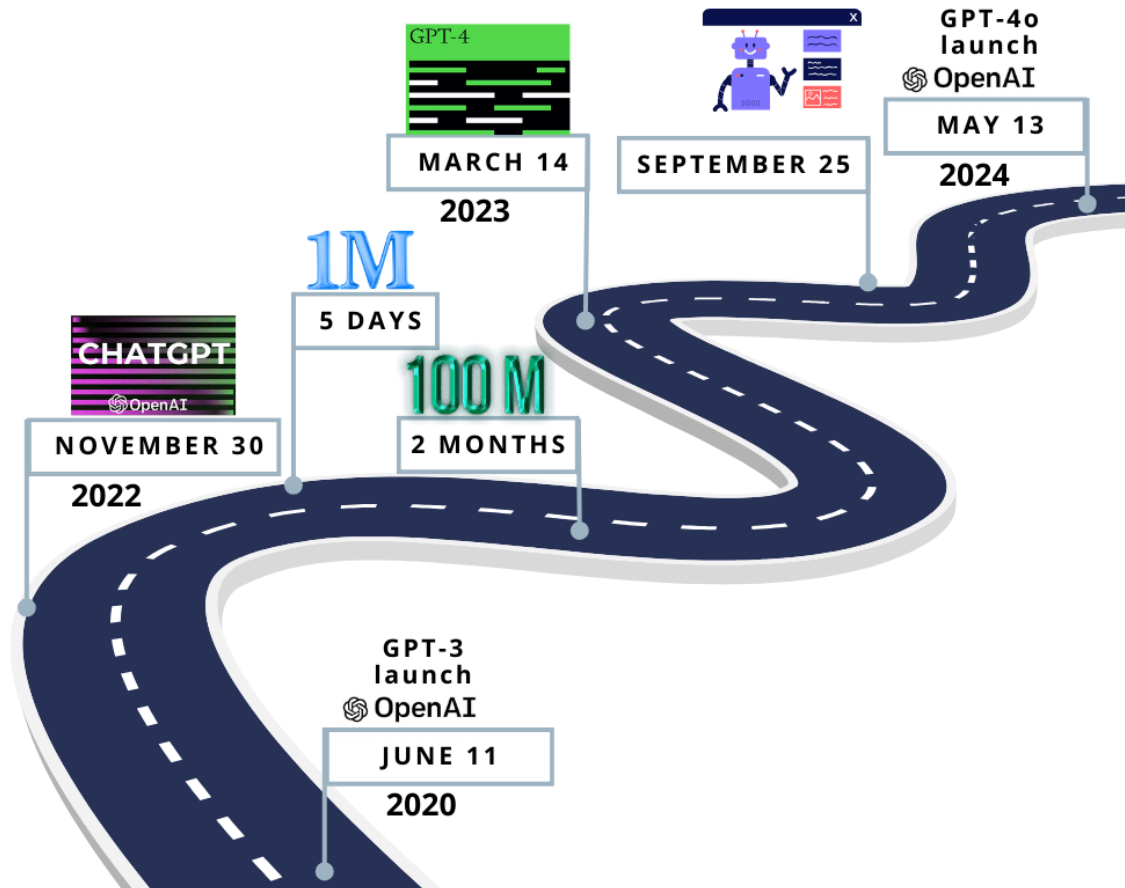
It is noteworthy that ChatGPT has the capacity to concurrently handle a maximum of ten documents. Nonetheless, a deliberate choice was made to adhere to the principles of Analytical Entwining, which serve as the foundational framework for this analytical method. Consequently, commands were issued to ChatGPT and documents were sequentially uploaded.

The interaction with the model unfolded in two distinct phases, each tailored to each specific objective. Initially, text document 1A was uploaded and ChatGPT was instructed with prompt No. 1 until completion of this document type, followed by the commencement of work on each image document type. Subsequently, image document 2A was uploaded, and ChatGPT was directed with prompt No. 2 until completion of this document category. This methodological procedure was adopted after preliminary tests with the model, which demonstrated the efficacy of overseeing the coding process and evaluating ChatGPT's responses in alignment with the coding criteria of Analytical Entwining integrated with GenAI.

Despite its enhanced capabilities, GPT-4 shares certain limitations with its predecessors, such as the potential to “hallucinate” facts and commit reasoning errors (OpenAI, 2023a). In this research, continuous monitoring was imperative due to the occurrence of “hallucinations” or erroneous outputs during the interactions with ChatGPT. “Hallucinations”, in the context of LLMs, refer to instances where the model generates factually incorrect or misleading information presented as truth, which can compromise the integrity of data processing and output. Therefore, vigilant oversight during human-AI collaboration is essential to ensure the ethical, efficient, and responsible use of these AI text generators. This proactive approach facilitates the mitigation of risks associated with AI-generated content, reinforcing the importance of human oversight in managing and correcting AI behavior, encompassing strategies from rigorous human review to providing additional contextual grounding for responses.

In this study, the 60 documents analyzed were selected based on the following inclusion criteria: the trajectory of technological advancements in ChatGPT and this research specific objectives. Regarding ChatGPT, I considered five intervals that refer to the time between events or milestones defined by specific technological releases of OpenAI's LLMs (see Figure 27).

Figure 27 – The Journey of OpenAI GPT Models



Source: created by the author based on Open AI (2015-2024).

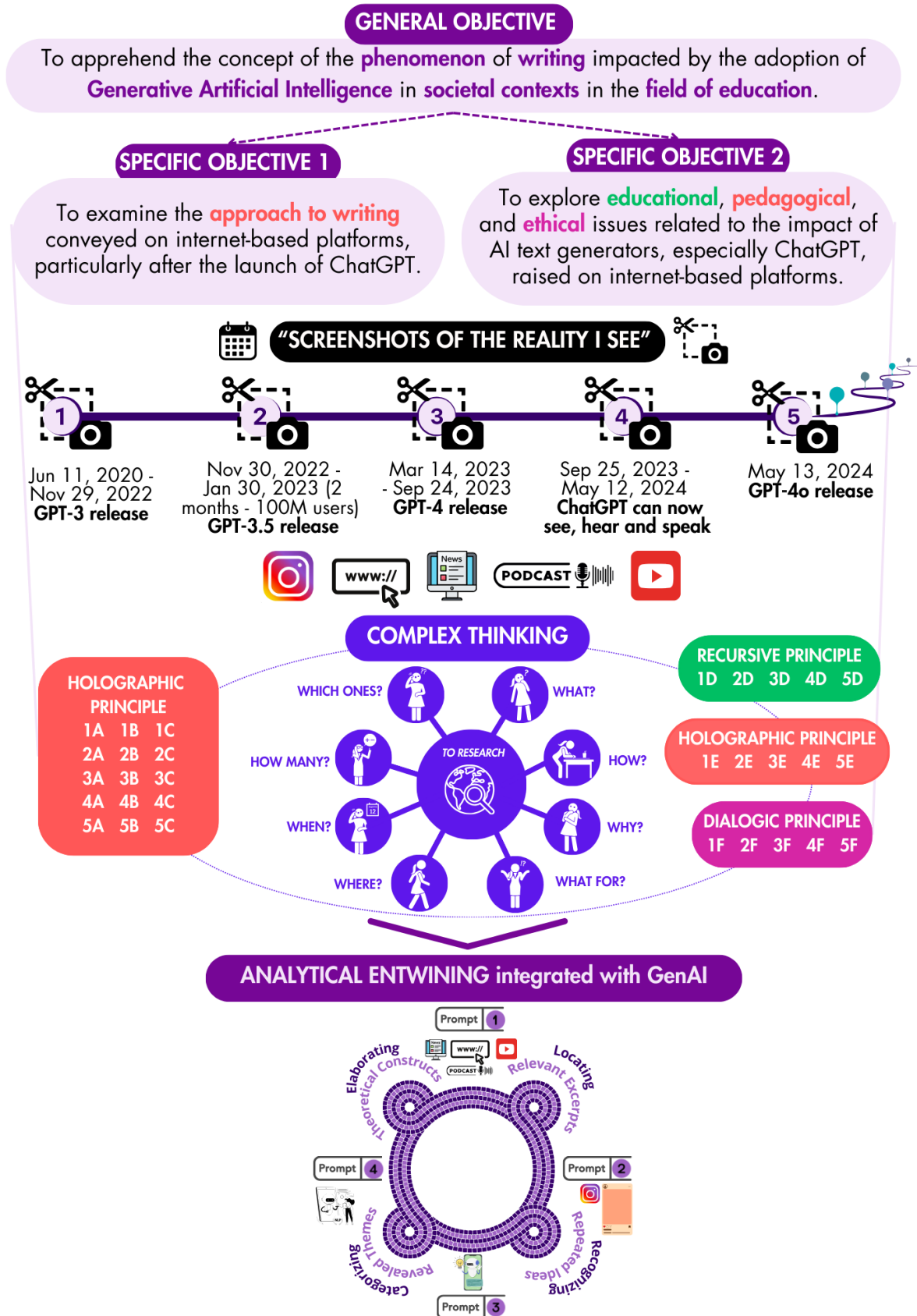
The initial interval is associated with the release of GPT-3, representing a milestone in the field of NLP owing to its unprecedented capacity in generating human-like text through extensive pre-training. The subsequent interval begins with the launch of ChatGPT, a groundbreaking variant of GPT-3 known as GPT-3.5. This version introduced enhanced conversational capabilities, allowing for more coherent and context-aware interactions. Additionally, this period is notable for ChatGPT reaching 100 million users within two months, highlighting its widespread acceptance and applicability.

The third interval starts on March 14, 2023, with the public release of GPT-4. This model has introduced noticeable improvements in text comprehension and generation, delivering more precise and sophisticated responses. GPT-4 also marks the beginning of the fourth interval on September 25, 2023, with OpenAI's announcement of the model's multimodal capabilities. These developments signal a transition to integrating voice and image capabilities, enhancing the interface to support vocal interactions and enabling users to provide visual inputs to ChatGPT for more intuitive communication.

The fifth and final interval begins on May 13, 2024, with the introduction of GPT-4o, showcasing the latest advancements in deep learning to date. The letter “o” stands for omni — suggesting OpenAI’s intention to achieve omnipresence — with capabilities such as human-like response times in conversations and significant improvements in handling non-English language text. These intervals compose the “screenshots of the reality I see”, defined in accordance with the Complex Thinking epistemology.

Concerning the second inclusion criterion, documents were selected based on their relevance to each specific objective. To achieve the first objective — to examine the approach to writing conveyed on internet-based platforms, particularly after the launch of ChatGPT — the first 30 documents focusing on GenAI and writing in educational contexts were selected. Additionally, to address the second specific objective, another 30 other documents were chosen for data analysis. The selection was influenced by the three main contexts: pedagogical (associated with methods or theory of teaching writing), ethical (concerning beliefs, what is morally right or wrong), and educational issues (related to the impact of AI text generators, especially ChatGPT, as discussed internet-based platforms). These criteria are depicted in Figure 28, the final image of this section, in which I also summarize my methodological path.

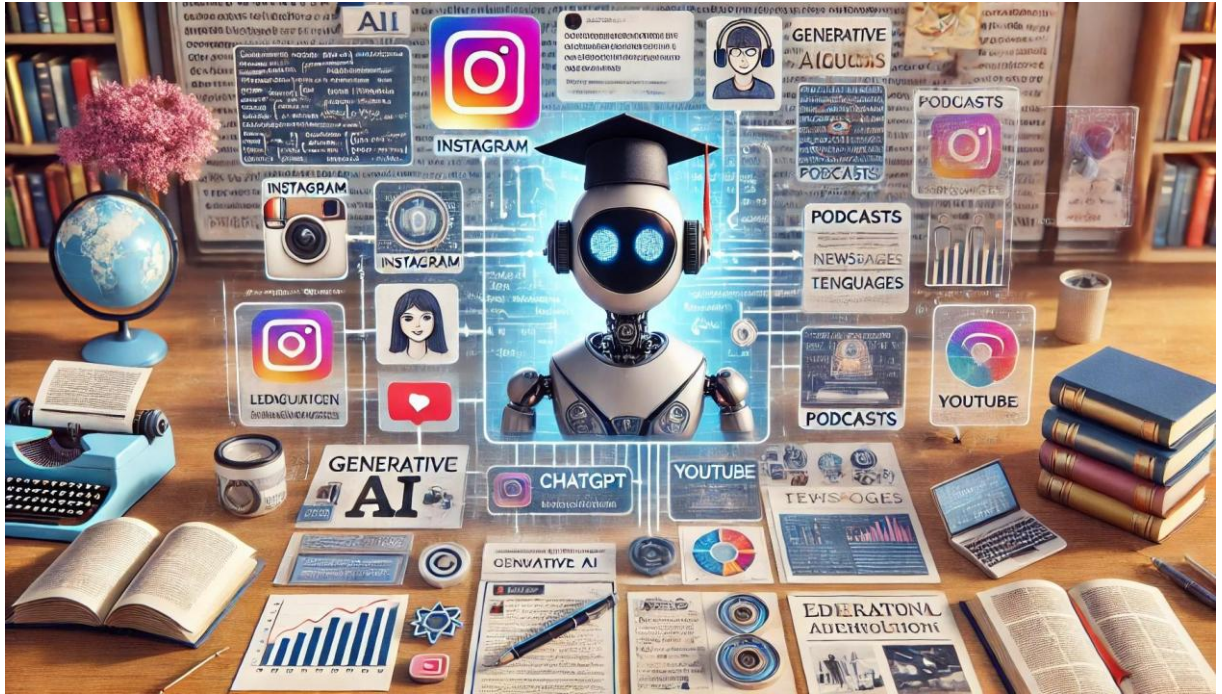
Figure 28 – Methodological Path



Source: created by the author based on Boa Sorte *et al.* (2023), Morin (2015), and Petraglia and Moraes (2022).

This image depicts the two strategies implemented to achieve my research objectives. The first strategy, “screenshots of the reality I see”, consists of screenshots numbered from 1 to 5. These numbers indicate predefined intervals representing the technological advancement trajectory of ChatGPT. Each screenshot is labeled with a combination of a letter and a number and contains two documents. Documents labeled with letters A, B, and C relate to specific objective number one and the holographic principle, while letters D, E, and F align with specific objective number two. This second objective engages with the three principles of Complex Thinking: recursive, holographic, and dialogic. The “screenshots of the reality I see” symbolize the interconnectedness of the phenomena investigated in this study: writing, education, GenAI technologies, and the principles of Complex Thinking. The second strategy integrates ChatGPT’s capabilities into the four analytical movements via prompt engineering. A collection of 60 documents, including Instagram posts, website articles, digital newspaper articles, podcasts, and YouTube videos, was analyzed using Analytical Entwining integrated with GenAI. This analysis resulted in the generation of eight theoretical constructs, which I discuss in the subsequent two sections.

SECTION 3



APPROACHES TO WRITING IN EDUCATION WITH GENERATIVE AI¹⁰

¹⁰ Image generated using OpenAI's DALL-E image generation tool on June 28, 2024. The prompt used for generation was: "I am a PhD candidate researching in the area of education, languages, and technologies. I am currently focusing on coding the collected data. Generate an image that depicts ChatGPT working on data analysis. The research focuses on generative artificial intelligence in education, AI-text generator platforms, and writing. This task needs to follow some criteria: the images must show the data: Instagram posts, Digital newspaper articles, Podcasts, and YouTube videos, the image must align with the research theme. Generate an image bearing in mind the purposes: to showcase a representation of analytical movements carried by ChatGPT".

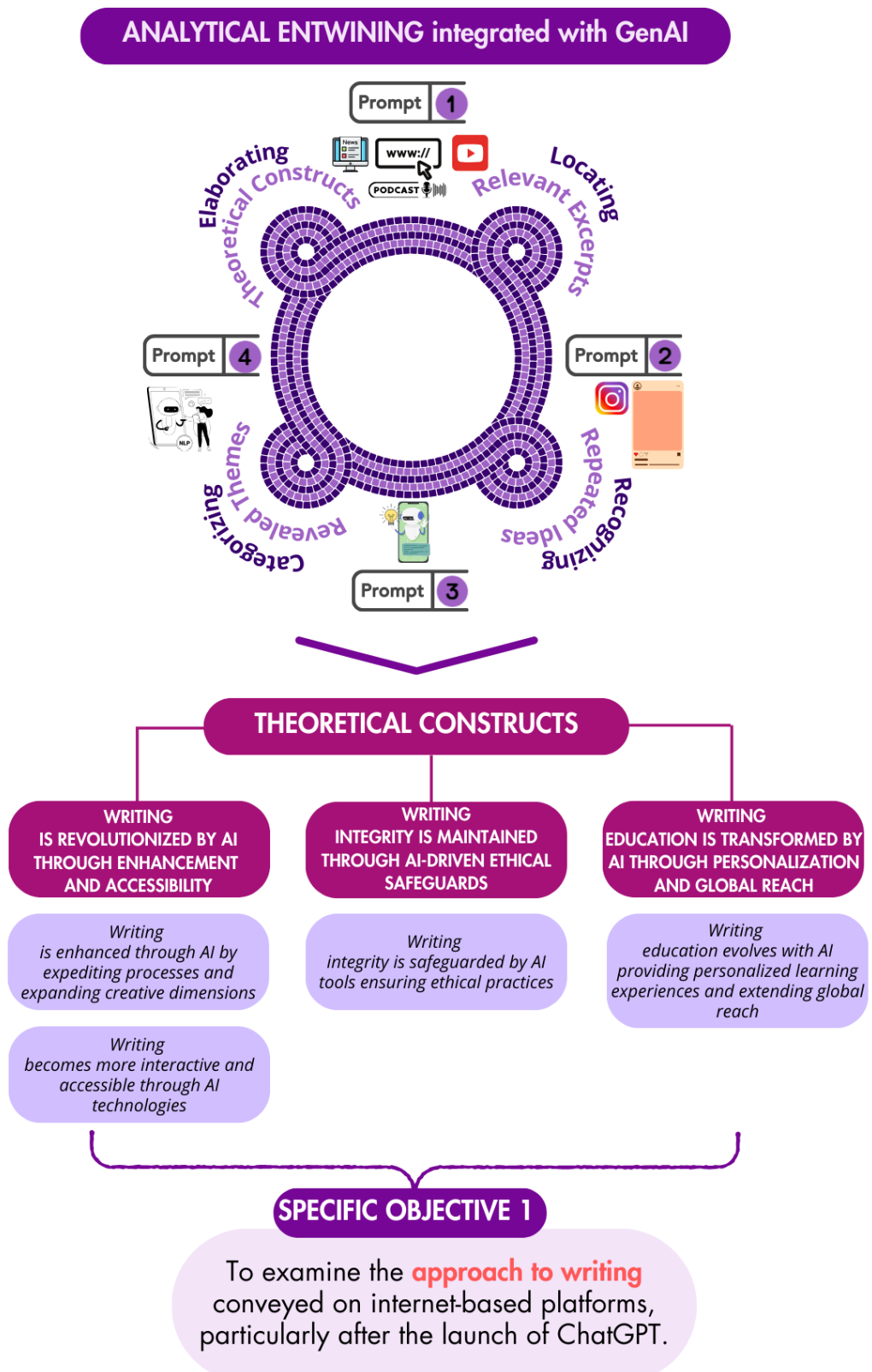
3 APPROACHES TO WRITING IN EDUCATION WITH GENERATIVE AI

“Writing has been with us now for so long
that we’ve lost the habit of thinking of it
as an invention” (Dibbell, 2010, p. 1).

This section opens with a summary of the four themes that were essential in developing the constructs discussed here (see Figure 29)¹¹. In this analytical path, considering the “screenshots of the reality I see” in light of Complex Thinking principles (Morin, 2015) symbolize the interconnectedness of the phenomena investigated in this research: writing, education, and GenAI technologies.

¹¹ Following the conventions by Auerbach and Silverstein (2003), theoretical constructs are written in capital letters and revealed themes are written in italics.

Figure 29 – Theoretical Constructs: specific objective 1



Source: created by the author (2023).

I initiate the presentation and analysis of the research findings, directly addressing the first specific objective of the study. It refers to writing as a phenomenon, given that it is a life experience (Ravagnoli, 2017), interconnected with societal aspects, and recognizes writing as an inherently social practice. This understanding is grounded in the holographic principle of Complex Thinking (Morin, 2015), which acknowledges the interrelatedness and interdependence of all components within a system. The documents analyzed in this study — YouTube videos, podcasts, website and digital newspaper articles, and social media posts — serve as bridges, capturing “screenshots of the reality I see” that exemplify this interconnectedness.

Following this principle, every component of the writing process is embedded within a larger societal context, reinforcing that no element stands alone. The interpretation of words and texts depends heavily on their contextual use, underscoring the necessity to view them within their societal, cultural, and knowledge frameworks. By employing a cognitive framework that fosters connections among seemingly unrelated elements, writing studies are positioned as integral to broader educational and societal contexts. Thus, education must adapt to societal and technological changes that impact writing, reflecting the holographic principle where each individual embodies societal aspects through language, culture, and norms (Morin, 2000).

This section is divided into three subsections, each focusing on a different theoretical construct elaborated through the movements of Analytical Entwining integrated with GenAI and in collaboration with ChatGPT. For each construct, the discussion begins by outlining its foundational themes. Subsequent analysis involves citing scholars who comment on these constructs, using excerpts from the literature and research data to deepen the discussion. This approach is systematically applied to all three constructs.

3.1 Writing is revolutionized by AI through enhancement and accessibility

The theoretical construct WRITING IS REVOLUTIONIZED BY AI THROUGH ENHANCEMENT AND ACCESSIBILITY¹² combines themes that fundamentally alter the nature of writing. Specifically, GenAI enhances writing by expediting processes and expanding creative dimensions, simultaneously making writing more interactive and accessible through

¹² Following the conventions by Auerbach and Silverstein (2003), theoretical constructs are written in capital letters.

advanced technologies. This construct emphasizes the transformation of the writing process through increased efficiency, creativity, and enhanced user engagement. The merging of these themes underscores a shift towards a more dynamic and accessible writing environment facilitated by AI innovations.

Building on the ways GenAI fundamentally alters the nature of writing, examining this construct through the lens of Complex Thinking principles (Morin, 2015) offers deeper insight into the systemic changes within this domain. AI text generators continuously refine and evolve through iterative feedback loops from user interactions, demonstrating the recursive principle by reflecting each layer of improvement back onto the system, leading to progressively sophisticated writing aids. Furthermore, each AI tool, while part of a larger system, encapsulates the entire functionality of the writing process but contributes uniquely to specific aspects like grammar enhancement and style personalization.

This encapsulation demonstrates the holographic principle, as every component contains the whole in its functionality, mirroring the entire writing ecosystem. This refers to Morin's view, in which the whole is greater than the sum of its parts because each part contains specific characteristics that are not apparent when considered only as part of the whole. The ongoing interactions between these AI tools and the users create a dialogic relationship, fostering co-evolutionary development in writing practices and illustrating the dialogic principle. This complex interplay of components reflects the system as a whole and highlights how each part contributes to and is influenced by the system, underscoring the notion of system. Together, these principles illustrate a sophisticated convergence of technology and human creativity, reshaping the landscape of written communication.

Technological advancements have historically reshaped the nature of writing. The transition from paper pages to digital screens signifies a revolutionary change, driven by the continuous development of technological devices (Kist, 2005). Further emphasizing this shift, the profound disruption of the Internet has altered several elements of society (Christensen, 2012), including the nature of writing, particularly its increasing use for online communication (Leu *et al.*, 2016). Both in research and classroom settings, the implications of these changes regarding the nature of writing in an online world, though still emerging, are being reconsidered and expanded (Christensen, 2012; Kist, 2005; Leu *et al.*, 2016). Consequently, a redefinition of texts and practices is proposed. This involves a pedagogical approach in which diverse forms of communication and meaning-making—visual, auditory, spatial, behavioral, and gestural modes—are acknowledged. It represents a transition from literacy (in the singular) to literacies (in the plural) (Kalantzis; Cope; Pinheiro, 2020).

The creation of writing, once a groundbreaking development, has become so embedded in human culture and social practices that we often forget its innovative beginnings. As mentioned in this section epigraph, writing's longstanding presence has diminished our sense of its original impact (Dibbell, 2010). However, this perspective is being renewed with the emergence of AI text generators, which represent a new wave of transformative technology in written communication. The application of GenAI technologies such as ChatGPT in writing is evidenced through specific prompts that catalyze both the speed and creativity of the writing process as shown in the screenshot 4C (see Figure 30).

Figure 30 – “Screenshot of the reality I see” 4C



Source: @eldessaullo (2023).

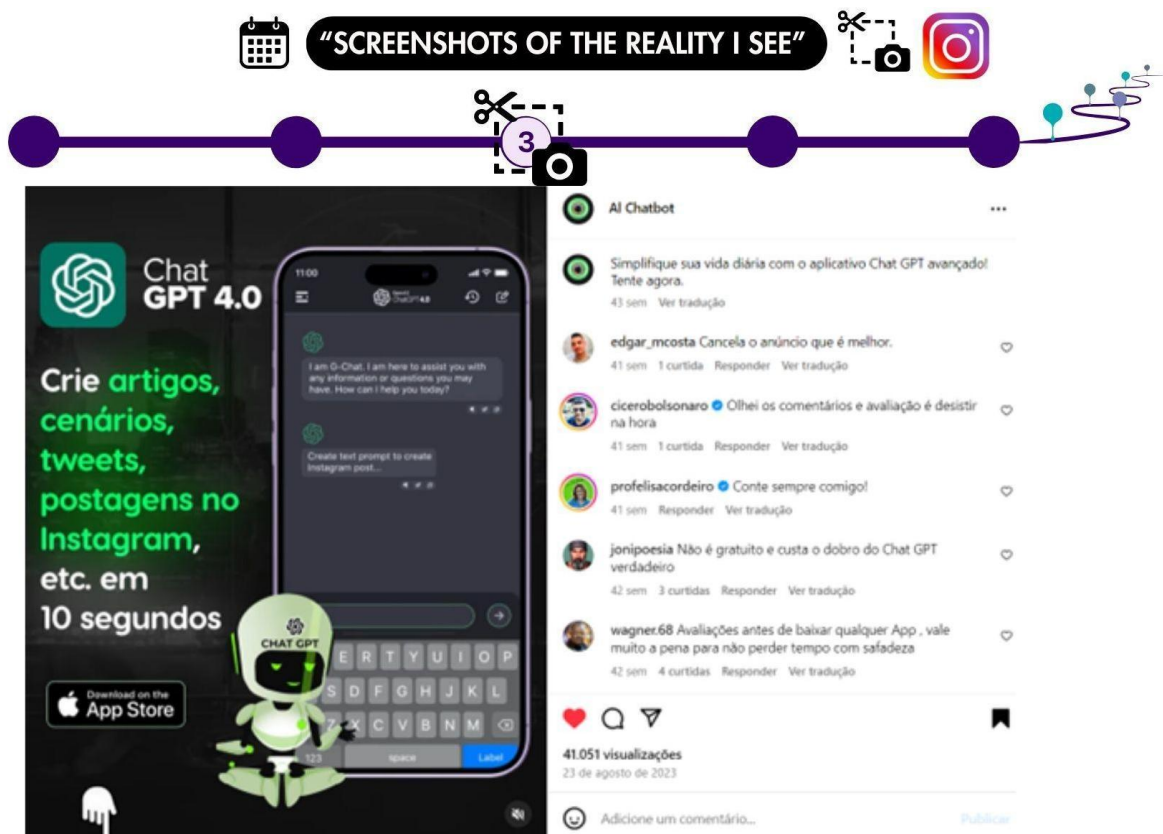
This image demonstrates the transformative power of GenAI in writing, highlighting how descriptive prompts used during collaboration with LLMs, like ChatGPT, can enhance both efficiency and creative output. It showcases how these prompts accelerate the writing process and expand creative possibilities, aiding authors in tasks from ideation to designing compelling book covers.

These GenAI systems are altering how we create and engage with text, reminiscent of how the original invention of writing revolutionized human communication by allowing the recording and sharing of knowledge across distances and generations (Fischer, 2021). By automating the writing process, AI text generators are broadening the horizons of written

expression and compelling us to rethink the concepts of authorship and creativity. This ongoing evolution highlights that writing is not a static achievement but continues to change dynamically in response to technological advancements. Adopting the term “evolution” implies understanding that it signifies “not quality grades, nor [...] stages in a model of ‘writing evolution’ (which does not exist). They are simply different forms that accommodate different linguistic and social needs as they arise” (Fischer, 2021, p. 329).

GenAI substantially improves the writing process by enhancing efficiency and broadening creative aspects through a variety of innovative applications. GenAI-driven tools like ChatGPT and other LLMs streamline the writing process by reducing the time required to complete tasks and improving the quality of output. For instance, in a study involving midlevel professional writing tasks, the use of ChatGPT decreased the average time taken by 40% and increased output quality by 18%, demonstrating major productivity gains and enjoyment of the writing process for users (Noy; Zhang, 2023). The screenshot 3B (see Figure 31) also illustrates the advancements in AI-powered content creation, as ChatGPT enables the creation of diverse digital content in a matter of seconds, reshaping user interactions across multiple platforms.

Figure 31 – “Screenshot of the reality I see” 3B



Source: @AI Chatbot (2023).

The illustration offers a glimpse into how GenAI, particularly through technologies like ChatGPT, enhances content production efficiency. This is evidenced by its capacity to produce articles, social media updates, and various other forms of digital content rapidly and effectively. Users' comments highlighting the positive impact and growing reliance on GenAI applications reflect the enthusiasm for new technology and its practical benefits in daily digital interactions. However, these views contrast with many opposing and skeptical opinions arguing many responses. This duality aligns with a historical narrative of responses, where new technology is often met with either enchantment or fear (Lemos, 2013). This often leads to neglect ethical concerns, dependency issues, and the potential decline in critical thinking due to excessive reliance on AI.

In examining these phenomena, the principles of Complex thinking (Morin, 2015) emerge as a dynamic network where elements interact in intricate and interdependent ways, leading to the emergence of new properties. I first identify the holographic principle because the influence of GenAI on content production reflects the intricate whole within each part, where each instance of GenAI use encapsulates the broader system's characteristics. Secondly, the recursive principle is expressed by the efficacy of GenAI technologies like ChatGPT involving repeated cycles of feedback and adaptation, where outcomes inform ongoing improvements and user behaviors.

Thirdly, the dialogic principle emerges through the continuous interaction and negotiation between human users and GenAI systems, fostering a dynamic interplay that shapes content creation and digital practices. The dialogic principle is also highlighted by the contrasting views within the community that uses AI text generators. The enthusiastic embrace of these platforms for practical benefits is in constant dialogue with skeptical views that caution against potential downsides, such as ethical neglect and reduced critical thinking. This principle emphasizes the importance of ongoing conversations and multiple viewpoints that shape the understanding and evolution of AI technologies.

Lastly, the notion of system is crucial, recognizing that GenAI operates within a complex, interconnected network of technologies, users, and educational practices, each influencing and being influenced by the other. These principles state the need for an integrative approach to understanding and responding to the complexities introduced by GenAI in content production.

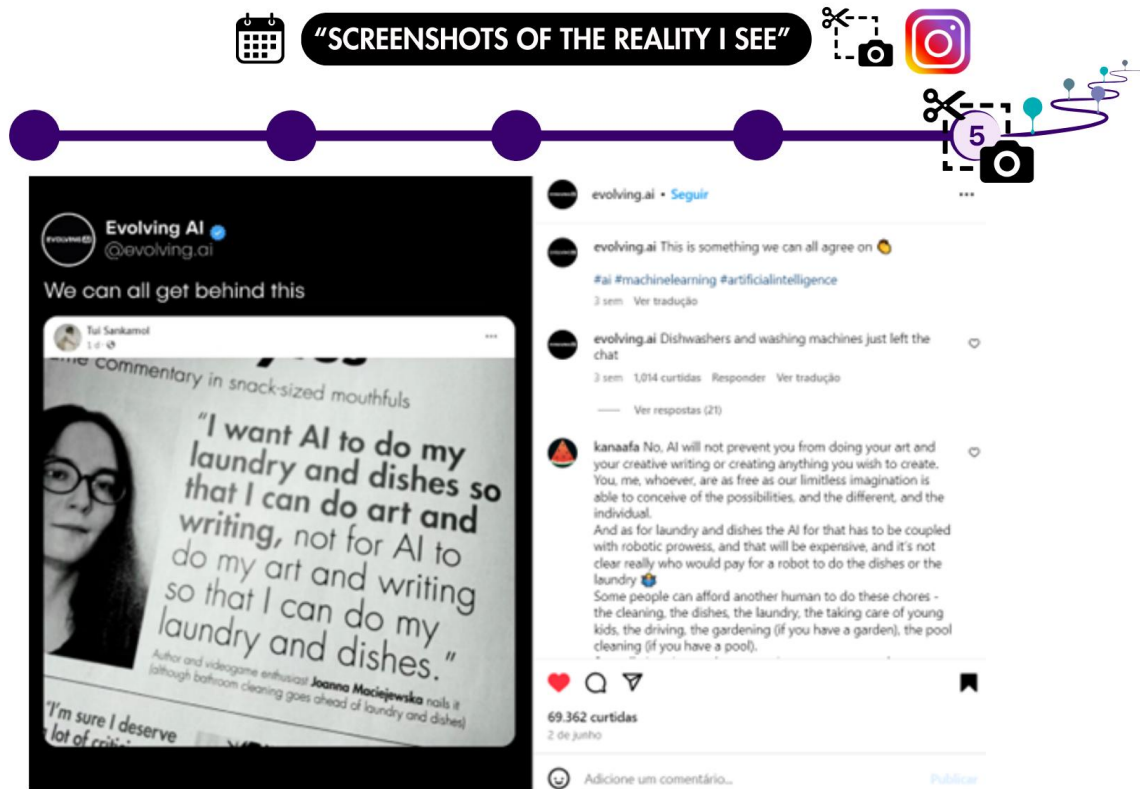
Similarly, LLMs utilized in scientific writing possess the capability to efficiently produce text of superior quality at a rapid pace. It is crucial, however, to carefully consider ethical aspects, including the impact on employment opportunities and the risk of disseminating

inaccurate or deceptive information, and take appropriate measures to mitigate these concerns (Kammer *et al.*, 2023).

Beyond efficiency, GenAI also extends the creative dimensions of writing. For example, AI has the capability to create new compositions from existing images and aid artists in transcending the constraints of the human mind, thereby stimulating novel forms of creativity and innovative designs (Dawood, 2023). In creative writing, AI's NLP abilities can propose new content and ideas, cultivating a "machine-in-the-loop" strategy that assists writers in discovering new creative pathways, despite potential variations in its impact on creativity among users (Plate; Hutson, 2022). Additionally, the emergence of writing robots capable of managing the entire content creation process — from selection to publication — showcases AI's potential to industrialize and enhance article production, significantly elevating creative efficiency (Li; Zhang, 2020).

GenAI reshapes creative practices by acting as a filter and gatekeeper, integrating diverse information sources and mediating between human activity and these sources, which can lead to the development of novel ideas, but reduce the qualitative diversity of inspiration (Atkinson; Barker, 2023). These discussions, highlighted in the screenshot 5B (see Figure 32), emphasize the popular desire for AI to serve as an assistance in mundane chores, ensuring that humans can reserve their time and mental energy for more creative pursuits like art and writing.

Figure 32 – “Screenshot of the reality I see” 5B



Source: @evolving.ai (2024).

The image captures key sentiments from social media, emphasizing the role of AI as a supportive tool rather than a replacement for human creativity. It reflects a broader societal conversation on preserving human-centric tasks, particularly those involving creativity, while allowing AI to handle routine tasks like dishwashing and laundry. This distinction clarifies public expectations and envisions a future where GenAI improves our daily lives by taking over ordinary tasks, enabling deeper involvement in rewarding and creative activities.

The integration of GenAI in writing also extends to addressing writer's block, where LLMs can serve as a conversational partner, mimicking the benefits of talking to others, helping writers navigate through creative blocks, and maintaining the writer's authentic voice (Gilbert, 2023; Jacob; Tate, 2023).

In the light of Morin's (2015) Complex Thinking, in this dynamic network, AI interacts with various elements of the writing process—such as routine tasks, creative methods, and content improvement strategies—in intricate and interdependent ways. This interaction fosters the emergence of new properties and behaviors, including enhanced efficiency and expanded creative potential, thereby extending the boundaries of human creativity (Dawood, 2023;

Gilburt, 2023; Jacob; Tate, 2023; Li; Zhang, 2020; Noy; Zhang, 2023; Plate; Hutson, 2022; Reza *et al.*, 2023).

3.2 Writing integrity is maintained through AI-driven ethical safeguards

In the domain of ethical practices within writing, the construct WRITING INTEGRITY IS MAINTAINED THROUGH AI-DRIVEN ETHICAL SAFEGUARDS is supported by themes asserting that writing integrity is safeguarded by AI tools that ensure adherence to ethical standards. It highlights the critical role of AI technologies in upholding the integrity and authenticity of written content. By focusing on the ethical dimensions of AI applications in writing, this construct stresses the importance of maintaining truthful and reliable content, which is fundamental in preserving public trust and the credibility of written works.

The integration of AI tools in academic environments has divided opinions among educators and scholars. “*Ci sono due campi nel mondo accademico. Il primo è quello degli ‘early adopters’ dell’intelligenza artificiale, il secondo è quello dei professori e degli accademici che pensano che l’AI corrompa l’integrità accademica*” (my translation). This excerpt from the screenshot 3C (see Figure 33) captures the core debate: the first group consists of early adopters who embrace AI technologies such as ChatGPT for their potential to enhance research and educational practices, while the second group includes educators and scholars who view the widespread adoption of AI tools as a potential threat to the established standards of academic integrity.

Figure 33 – “Screenshot of the reality I see” 3C



Source: Arpinati (2023).

This dichotomy underscores a fundamental debate on the optimal utilization of AI’s capabilities while ensuring that ethical standards in scholarly work are not compromised. This division points to the critical need for developing and implementing AI-driven ethical safeguards that uphold writing integrity. It is crucial that these tools are used responsibly within academic settings to maintain trust in educational outcomes and scholarly publications. Through such measures, academia can navigate the challenges posed by AI, fostering an environment where technological advancements and ethical standards coexist, aligning with the dialogic principle.

AI tools play a role in maintaining the integrity and authenticity of written content through various approaches and methodologies. One significant contribution is the use of advanced models like BERT to identify AI-generated content by analyzing contextual embeddings and revealing complex patterns indicative of AI origin, thus safeguarding the integrity of human-authored content (Chakraborty *et al.*, 2024). Co-audit tools have emerged to help users double-check AI-generated content for correctness, especially in outputs like summaries, tables, or code, guaranteeing that errors are minimized and quality is preserved

(Gordon *et al.*, 2023; Tamilselvi *et al.*, 2023). AI-powered text-checking services like QuillBot and HiveModeration have demonstrated efficacy in detecting AI-generated content, although they sometimes fail to identify AI signs in original texts, highlighting the need for continuous improvement in these tools (Lukianenko; Shastko; Korbut, 2024; Tamilselvi *et al.*, 2023).

QuillBot, Grammarly, and Wordtune are AI-powered writing tools designed to enhance various aspects of writing. QuillBot specializes in paraphrasing and summarizing text to help avoid plagiarism and improve clarity. Grammarly acts as a comprehensive writing assistant, offering corrections and suggestions for grammar, style, and tone, making it invaluable for producing polished and professional text. Wordtune focuses on improving readability and style, offering sentence restructuring and word choice enhancements to better engage and communicate with readers. Together, these tools are beneficial for educators, students, content creators, and professionals seeking to refine their writing quality and promote academic integrity. Their integration, however, necessitates the adoption of ethical standards to prevent misuse (Tamilselvi *et al.*, 2023).

These approaches and methodologies integrate the recursive and dialogic principles (Morin, 2015). The recursive principle is evident as the system uses continuous feedback loops to refine and enhance its processes. Each iteration of AI analysis and human review feeds back into the system, progressively improving its ability to detect and differentiate AI-generated content. Simultaneously, the dialogic principle is demonstrated through the ongoing dialogue between human cognition and AI processing. This symbiotic interaction is also captured in the screenshot 5A (see Figure 34), which addresses the transformative potential and challenges GenAI brings to educational integrity. “While some regard AI as a potentially transformative technology, creating a more inclusive and personalized education, for others it makes it impossible to trust coursework grades” (excerpt from the screenshot 5A).

Figure 34 – “Screenshot of the reality I see” 5A



Source: Morrison (2024).

In the referenced article, researchers at Cambridge University have identified distinctive characteristics of essays written with the assistance of ChatGPT. They observed a high frequency of Latin-derived words, pleonasms, and a consistent use of the Oxford comma. GenAI assists in generating informative and reflective content but is inadequate in areas of analysis and comparison. The small-scale study highlighted how students use AI, ranging from direct copying to using prompts for further research. Despite the advantages of quick information access, there is a consensus that relying solely on AI could compromise academic standards. These findings state the necessity of integrating GenAI into educational practices to uphold ethical standards and maintain academic norms (Afifah, 2024), while also highlighting the role of fostering multiliteracies to achieve these goals (Kalantzis; Cope, 2023).

The swift adoption of GPT-based text generators has required critical thinking and mindful use in academic writing, underscoring the importance of distinguishing between human and AI-generated content (Dingemanse, 2024). As LLMs continue to advance, efforts to detect AI-generated content in academic settings have intensified, with research focusing on the functionality and accuracy of detection tools to verify the authenticity of academic work. Additionally, conferences and discussions on integrity, open science, and AI's role in academia

highlight the importance of these tools in maintaining the integrity of written content (Dubinsky; Simón-Soro, 2023).

Machine learning models like the Generative Textual Likelihood Ratio (GLTR) have been proven to improve the detection rate of AI-generated text. The GLTR models enhance the human detection rate of AI-generated text from 74% to 99%, which is crucial in educational settings to prevent plagiarism and ensure the authenticity of student submissions (Prajapati *et al.*, 2024). Furthermore, studies evaluating the effectiveness of online detection tools such as GPTZero, ZeroGPT, Writer ACD, and Originality reveal significant variability in their accuracy, with some tools like Originality showing enhanced sensitivity to AI-generated text patterns, indicating the need for more refined detection methodologies (Bellini *et al.*, 2024).

In scientific research, a three-dimensional model consisting of transparency, integrity, and accountability has been proposed to define the responsible use of AI, along with “AI Usage Cards” to standardize reporting and promote ethical AI usage, ensuring the integrity of scientific outputs (Wahle *et al.*, 2023). Journals and publishers also leverage AI to screen submissions for potential misconduct, such as plagiarism and data manipulation, ensuring the integrity of published manuscripts while emphasizing the importance of human review to verify AI-identified cases and maintain accountability (Hosseini; Resnik, 2024).

Editorial policies have been developed to guide the appropriate use of AI in authorship, peer review, and editorial processing to prevent the erosion of scientific integrity (Leung *et al.*, 2023). Additionally, the gap between AI-generated and human-written scientific texts in terms of depth and quality highlights the need for ongoing optimization of AI models to produce high-quality content while addressing ethical and security concerns (Ma *et al.*, 2023). Finally, the vulnerability of existing plagiarism detection algorithms to AI-based tools underscores the importance of developing more robust methods to detect and prevent academic dishonesty (Xiao; Chatterjee; Gehringer, 2022).

In the creative sector, AI tools democratize the generation of high-quality creative outputs, allowing individuals without traditional expertise to express their aspirations and emotions. This sustains the perceived intentionality and authenticity of creative works (Moura, 2023). However, the rapid adoption of AI-generated content challenges authenticity, necessitating the use of watermarking techniques to detect and prevent misuse. These methods, though promising, require further refinement to be fully effective (Jiang; Zhang; Gong, 2023). Through the lens of Complex Thinking (Morin, 2015), the holographic principle enhances this landscape by suggesting that each piece of AI-generated content, despite being a single entity, encapsulates comprehensive creative dynamics. This broader view reflects that individual

works are not isolated creations but integral parts of the collective creative domain, influencing and mirroring the entire artistic ecosystem.

Collectively, AI tools are being tested for their effectiveness in detecting artificially generated information across multiple domains, with varying degrees of success, highlighting the need for continuous improvement in detection technologies to maintain content authenticity (Akram, 2023). This context issues a demand for parallel developments in education. The “Writer’s Integrity” framework enhances this by monitoring the writing process rather than the final product, capturing the distinct behavioral footprint of human authorship, validating human intellectual work and preserving academic integrity and intellectual property rights (Aburass; Abu Rumman, 2024).

The integration of GenAI tools such as ChatGPT into educational settings requires practices that focus on the creation of detailed and effective prompts to facilitate meaningful human-AI interactions (dos Santos; Boa Sorte; de Oliveira, forthcoming). These prompts enable functional and ethical use of AI text generators and foster critical thinking skills. By serving as a scaffolding tool, GenAI helps students overcome language barriers and cognitive challenges, enhancing their creativity and collaboration. This approach also empowers students with the necessary expertise to navigate adeptly in an AI-driven world, teaching them the skills needed to critically analyze AI-generated content and use it effectively in their learning and writing processes.

Considering these developments, the phenomenon of writing impacted by GenAI is a complex system when viewed through the lens of the recursive, dialogic, and holographic principles (Morin, 2015). Each piece of AI-generated content is not simply a static text but part of a broader, dynamic system in which content is continuously created, interpreted, and recreated, thereby mirroring the recursive nature of complex systems. Similarly, the dialogic principle emphasizes that AI-generated texts facilitate ongoing conversations between human and machine, each learning and adapting from the other.

To expand on this view, the holographic principle demonstrates that in complex systems, each part reflects the entire system. This principle shows how individual interactions with GenAI represent and actively influence overarching educational goals, such as fostering critical thinking and ethical engagement. These interactions are more than reflections. They are formative elements that help shape both the educational framework and cognitive development. Recognizing writing impacted by GenAI as a complex system implies that this phenomenon continuously evolves with technological advancements. It reveals the need for educational

practices that develop our ability to engage both critically and creatively in this evolving landscape.

3.3 Writing education is transformed by AI through personalization and global reach

The transformation of writing education through AI is represented in the construct WRITING EDUCATION IS TRANSFORMED BY AI THROUGH PERSONALIZATION AND GLOBAL REACH. This theoretical construct explores how AI reshapes educational experiences by providing personalized learning opportunities and extending the accessibility of educational content across diverse languages and regions. The themes elaborated here illustrate a significant evolution in writing education, emphasizing the capabilities of GenAI to cater to individual learning needs and bridge educational gaps globally. This shift offers possibilities for enhancing the learning experience and for democratizing access to quality education worldwide.

AI's ability to personalize learning experiences and extend educational content globally represents a substantial advancement in writing education, offering new opportunities for students and educators alike to engage with and benefit from cutting-edge technologies (Brady *et al.*, 2023). This global reach is supported by the increasing number of research papers on AI in education, highlighting the growing interest and collaboration in this field (Paek; Kim, 2021). However, the integration of AI in education is not without challenges. Issues such as algorithmic bias, privacy concerns, and overreliance need to be addressed to ensure the responsible use of AI technologies (Abd-Alrazaq *et al.*, 2023).

Complex Thinking (Morin, 2015) can foster substantial insights, particularly through its principles, in exploring the impact of GenAI on writing education. Recursively, AI systems refine their approaches based on ongoing feedback from student performance, continuously improving the educational process. Dialogically, the expanding body of research and international collaboration provides diverse insights that address critical challenges such as algorithmic bias and privacy concerns. Holographically, localized implementations of AI in writing education reflect broader global trends toward enhanced and accessible educational practices, highlighting the interconnected nature of these advancements. This framework facilitates a comprehensive understanding of AI's impact on writing education, emphasizing the necessity for a balanced and informed approach to technology integration.

In medical education, AI has shown significant promise in improving learning outcomes, such as in the AI-assisted medical image learning system, which enhanced diagnostic accuracy among students (Cheng *et al.*, 2020). This indicates the broader applicability of AI in various educational fields, including writing.

GenAI's capacity to provide timely and personalized feedback in educational environments, such as English as a Foreign Language (EFL) classrooms, encourages student involvement and improves grading efficiency, highlighting its role in enriching the instruction and acquisition of writing skills (Dong, 2023). However, the use of GenAI in writing education should be balanced with the intrinsic value of human writing experiences, focusing on the process rather than just the production of texts (Yoon, 2023).

The incorporation of GenAI in EFL classrooms illustrates Complex Thinking principles, particularly the holographic and dialogic. GenAI's role in providing personalized feedback boosts student involvement and efficiency, aligning with the holographic principle where each component reflects broader educational goals. Meanwhile, the dialogic principle surfaces in the ongoing balance between the benefits of GenAI and the intrinsic value of human writing experiences. This dynamic interaction ensures that technology enhances the educational process without diminishing the essential human elements of creativity and personal expression in writing.

The integration of AI in education, especially through LLMs like ChatGPT, has the potential to transform how students learn and engage with writing tasks. AI-driven tools can provide personalized feedback on assignments, as demonstrated by the Personalized Multimodal Feedback Generation Network (PMFGN), which generates accurate and diverse feedback by integrating multimodal inputs such as text, images, and audio (Liu *et al.*, 2020). This personalized approach is crucial in addressing individual learning needs and enhancing the educational experience.

AI's ability to analyze and optimize writing patterns, as exemplified by the Intelligent Online Assessment (IOA) English analysis model, helps students improve their writing skills through structured peer assessments and targeted feedback (Wu, 2023). These AI-powered tools leverage advanced ML and NLP algorithms to detect nuances in language use and structural integrity in students' writings. This enables them to offer precise corrections and actionable suggestions that improve students' understanding of academic English norms. Further, by automating the review process, these tools allow for more frequent and timely feedback, crucial for iterative learning processes. This model enhances students' writing proficiency and fosters

a deeper engagement with the mechanics of writing, such as grammar, style, coherence, and content as indicated in recent studies.

Additionally, AI's role in education extends beyond personalized learning; it also offers possibilities for facilitating the global dissemination of educational content. The advancements in NLP and transformer language models (TLMs) enable the creation of multilingual educational resources, making high-quality content accessible to a global audience (Gruetzemacher; Paradise, 2022). This potential benefit is also captured in the screenshot 5B (see Figure 35), an interview with Sal Khan, the founder and CEO of Khan Academy¹³. While discussing the broader implications of AI on education, he presents Khan Academy's impressive reach and impact: over 160 million registered users across more than 190 countries and availability in over 50 languages.

Figure 35 – “Screenshot of the reality I see” 5B



Source: CNBC Television (2024).

¹³ Khan Academy is an internet-based educational platform that is freely accessible, offering instructional videos, practice exercises, and customized learning dashboards across various subjects spanning a variety of academic disciplines. Through the utilization of sophisticated GenAI technologies, such as GPT-4 via its proprietary tool known as Khanmigo, the platform customizes the educational journey for each student, enabling them to advance at their own speed and targeting specific areas of academic challenge. Funded by donations and grants, Khan Academy aims to provide a high-quality education regardless of their geographic location, although accessibility might be constrained by the availability of internet connectivity and technological devices. Available at: <https://openai.com/index/khan-academy//> and <https://www.khanmigo.ai/>.

Despite the widespread reach of Khan Academy, leveraging AI and the internet to democratize education, the digital divide presents significant challenges in achieving truly universal access. A critical obstacle is the lack of reliable internet access for many individuals globally, which is fundamental to utilizing online resources like Khan Academy. Additionally, the absence of necessary technological devices such as computers, tablets, or smartphones limits the access of many students to these educational tools.

Beyond these digital gaps, broader societal inequities like poverty, inadequate infrastructure, and political instability severely impede educational access. Addressing these issues demands a collaborative approach among governments, non-governmental organizations, and other key stakeholders to forge an equitable educational landscape that extends beyond digital solutions.

This promise for democratizing access to quality education worldwide, often highlighted by proponents of educational technology, warrants critical examination. It raises questions about the actual efficacy of AI in bridging educational disparities across diverse geographic and socio-economic contexts. Such scrutiny is essential to discerning whether AI can truly deliver on its potential to democratize access to quality education globally.

The results from the three theoretical constructs addressed the first specific objective of this research. The key terms — revolution, integrity, and transformation — extracted from each construct, convey the approach to the phenomenon of writing on internet-based platforms, particularly after the launch of ChatGPT. According to Complex Thinking (Morin, 2015), revolution, integrity, and transformation are interrelated phenomena that interact within a dynamic system, collectively influencing and shaping the broader phenomenon of writing on internet-based platforms, especially after the launch of ChatGPT, by driving profound shifts in writing practices, upholding ethical standards, and continuously evolving writing processes.

SECTION 4



EDUCATIONAL, PEDAGOGICAL, AND ETHICAL ISSUES OF AI TEXT GENERATORS¹⁴

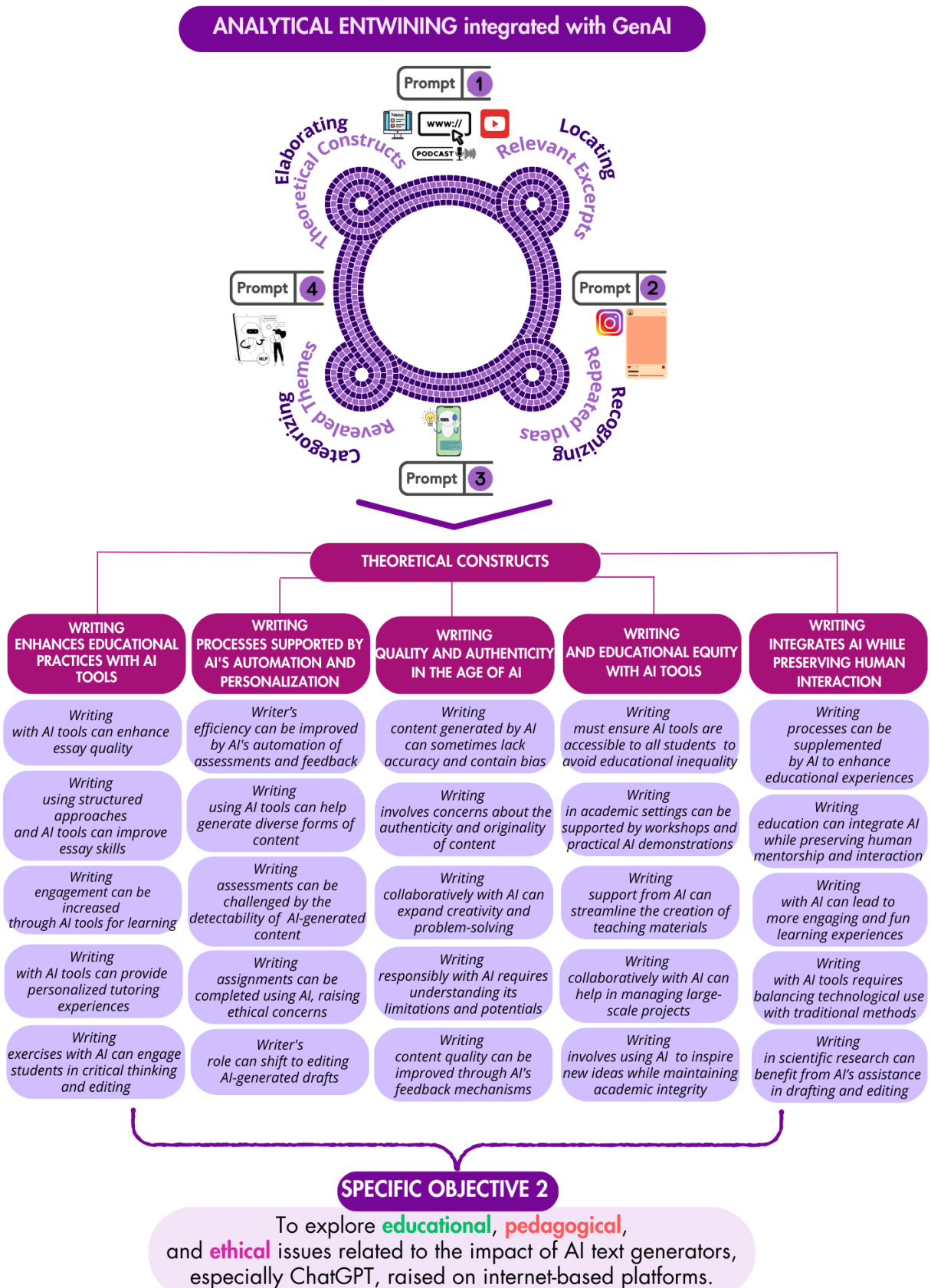
¹⁴ Image generated using OpenAI's DALL-E image generation tool on November 11, 2023. The prompt used for generation was: "Generate an image that shows human and machine integrating to write."

4 EDUCATIONAL, PEDAGOGICAL, AND ETHICAL ISSUES OF AI TEXT GENERATORS

“Writing words by hand is a technology
that’s just too slow for our times”
(Dibbell, 2010, p. 174).

This section presents the 25 revealed themes that were fundamental to the development of the constructs discussed herein (see Figure 36). In this analytical path, the “screenshots of the reality I see” interpreted through Complex Thinking principles (Morin, 2015) exemplify the interconnectedness of the phenomena studied in this research: writing, education, and GenAI technologies.

Figure 36 – Theoretical Constructs: specific objective 2



Source: created by the author (2023).

I initiate the presentation and analysis of the research findings, addressing the second specific objective of the study. This objective concerns the phenomenon of writing, recognized as a life experience (Ravagnoli, 2017), being impacted by the phenomenon of AI text generators, particularly ChatGPT. This influence spans three critical areas: educational, pedagogical, and ethical issues. Educational concerns focus on the broad impact of AI text generators on the educational landscape, including aspects such as assessment. Pedagogical issues relate specifically to strategies, methods or theories of teaching writing. Ethical considerations explore the moral implications, questioning what is right or wrong in the use of such technology in writing practices. The data supporting this analysis, “screenshots of the reality I see”, is derived from the documents found on internet-based platforms, phenomena that capture writing as a social practice. This understanding is underpinned by the principles of Complex Thinking: recursive, holographic, and dialogic (Morin, 2015).

Recognizing writing impacted by GenAI as a complex system is acknowledging it as a phenomenon whose dynamic nature continuously evolves with technological advancements. The recursive principle (Morin, 2015) reveals how educational impacts of AI on writing are not isolated events but rather cyclical processes that affect and are affected by the educational system at large. For example, the integration of AI in assessment practices both shapes and is shaped by evolving educational standards and learning outcomes. In terms of pedagogy, the holographic principle (Morin, 2015) applies where each part of the teaching methodology reflects the whole pedagogical framework. This is evident in how AI text generators like ChatGPT can be used to complement traditional teaching methods, thereby enhancing the holistic approach to writing instruction. This integration demonstrates how individual pedagogical techniques influenced by GenAI mirror the overall objectives and methodologies of educational institutions. Ethical issues are examined through the dialogic principle (Morin, 2015), emphasizing the importance of ongoing dialogue concerning the moral dimensions of using GenAI in writing. This dialogue involves multiple stakeholders — including educators, students, and policy makers — engaging in discussions about what is deemed right or wrong in the use of GenAI technologies. This principle encourages a broad and inclusive conversation that acknowledges diverse perspectives and the evolving nature of ethical standards in a digitally enhanced educational landscape.

This section is structured into five subsections, each dedicated to a distinct theoretical construct, elaborated through the movements of Analytical Entwining integrated with GenAI and in collaboration with ChatGPT. The exploration of each construct commences with a delineation of its essential themes. The following analysis includes references to scholars who

have contributed to the debate on these constructs, incorporating excerpts from literature and research data to enrich the discussion. This approach is uniformly applied across all the five constructs.

4.1 Writing enhances educational practices with AI tools

The theoretical construct WRITING ENHANCES EDUCATIONAL PRACTICES WITH AI TOOLS asserts that the integration of AI technologies into writing instruction improves educational outcomes. This is supported by themes including the enhancement of essay quality through AI-driven insights, the development of writing skills via structured AI-enhanced approaches, and increased engagement through interactive AI learning tools. Additionally, AI tools offer personalized tutoring experiences and promote critical thinking and editing skills.

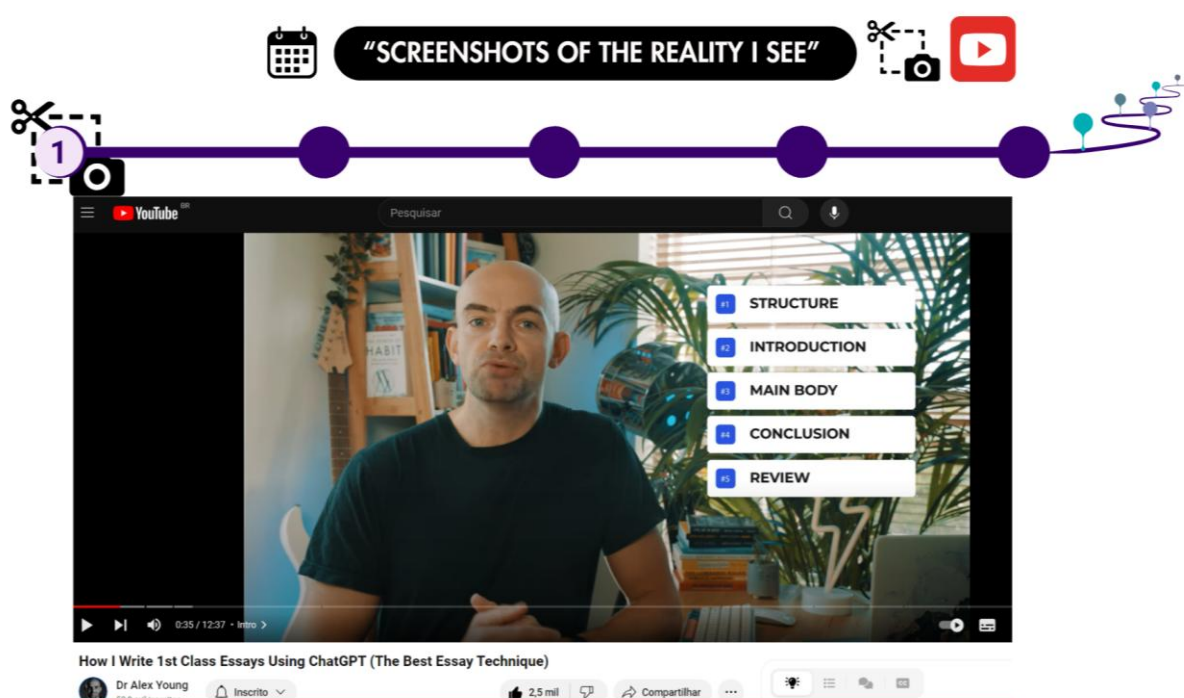
Written language is a technology learned and produced in social contexts, enabling the establishment of social bonds, construction of shared meanings, changes in the social presence of the one who writes and the realization of social actions. Writing is a social technology developed in order to serve communication between people, and its social value motivates both the difficult learning of material and symbolic technologies related to writing and the arduous psychological effort devoted to the act of writing (Bazerman, 2016).

In exploring the evolution of writing, it is evident that technological advancements have significantly reshaped cultural practices associated with writing, particularly within educational contexts. The proliferation of social media has popularized and fundamentally transformed writing into one of the most dynamic cultural practices today. In English language classrooms, this transformation is characterized by the integration of multimodal compositions and the critical engagement with remixed texts. This shift encourages educators to foster a curriculum that transcends traditional writing modalities, advocating for the inclusion of multiliteracies that mirror the nuanced demands of contemporary communication (Boa Sorte, 2018).

As we transition into an era dominated by AI literacy, it is crucial for educators and students to grasp the unique, non-human aspects of how GenAI functions, and to understand its challenges and limitations. This shift necessitates a new literacy agenda that is tailored to the emerging realities of the GenAI landscape. This new literacy framework should encompass a broader understanding of written text, to include the full range of Unicode characters used in contemporary texts, such as emojis, icons, and ideographs, linking writing with mathematics and coding. While literacy educators may not require deep expertise in these specialized fields,

it is imperative that mathematics and computer science educators integrate literacy education into their things. This holistic approach would make every educator a literacy teacher in the GenAI era. Moreover, the advancement of multimodal literacy, which merges traditional text with other media, acknowledges the historical multimodality of literacy and adapts to the nuanced transitions introduced by GenAI, which can generate diverse content forms from textual inputs (Kalantzis; Cope, 2024). For instance, the screenshot 1E (see Figure 37) provides strategies on utilizing ChatGPT to enhance essay writing skills, exemplifying these expanded capabilities in practice.

Figure 37 – “Screenshot of the reality I see” 1E



Source: Dr Alex Young (2023).

The screenshot 1E highlights a common challenge many students face in essay writing, noting the lack of formal instruction with the statement: “No one really teaches us how to write essays and getting a 1st can seem daunting”. It introduced a technique that employs a structured approach, significantly aided by GenAI technologies like ChatGPT, to demystify and improve essay writing. This method aims to clarify the process and increase both the efficiency and effectiveness of writing, which is crucial for students aiming for high grades. The integration of GenAI in this technique exemplifies the transformative impact of technology on educational practices, particularly in refining and enhancing more traditional academic skills.

AI tools have substantially enhanced writing skills and educational outcomes in academic settings by providing multifaceted support throughout the writing process. These tools assist in planning, drafting, editing, and revising, thereby addressing common challenges faced by writers of all proficiency levels. For instance, AI tools like ChatGPT can generate prompts and provide corrective feedback, improving learners' writing skills by suggesting enhancements in vocabulary usage, syntax, and discourse structure (Duncanson, 2024).

Through the lens of Complex Thinking (Morin, 2015), recognizing the coexistence of dualities—human and machine—in the phenomenon of writing impacted by GenAI is crucial. This awareness helps students understand what it means when we say ChatGPT can generate human-like texts. The dialogic principle (Morin, 2015) suggests that dualities and contradictions, while seemingly at odds, are not only inevitable but essential for a nuanced understanding of phenomena. This concept rejects simplified views of reality, which often perceives things in “black and white”, promoting instead a more complex understanding where contradictions coexist and inform each other. Embedded in this principle is the idea that opposition serves as a driving force in human thought and broader conceptual debates. Engaging with opposing concepts as a form of participatory problem-solving underpins the very nature of dialogic interaction (Bazerman, 2016).

Considering the breakthrough in deep learning, ChatGPT's text generation exemplifies this coexistence of human-like creativity and mechanical computation. Texts are generated by selecting the next word based on probabilities, demonstrating a unique integration of human cognitive patterns with machine efficiency (Wolfram, 2023). ChatGPT operates with whole words, drawing from a corpus of approximately 40,000 common English words, and starts generating sentences where each word is independently picked at random, mirroring the probability of its occurrence in a vast corpus sourced from millions of books. As an LLM, ChatGPT estimates sequence probabilities, using a model equipped with sufficient parameters to compute next-word probabilities effectively enough to produce reasonable essay-length pieces of text. This model functions through neural networks—simple idealizations of how human brains operate, arranged in layers of connected “neurons”. These artificial neural networks capture a human-like way of processing information (Wolfram, 2023), reflecting a complex interaction of simplicity and complexity. Furthermore, the structure and functioning of these neural networks embody the holographic principle (Morin, 2015), where each

component performs a specific function and simultaneously contributes to the holistic capability of the model, thus mirroring the overall cognitive process of language generation.

In educational contexts, AI tools have been leveraged to develop course materials and assist students in interacting with statistical and data science concepts responsibly, drawing parallels to the initial skepticism and eventual acceptance of calculators in classrooms (Ellis; Slade, 2023). AI-generated writing tools like ChatGPT present challenges that require pedagogical frameworks to teach students how to effectively partner with AI, ensuring that they can corroborate and incorporate AI-generated content responsibly (Tseng; Warschauer, 2023). The screenshot 2E (see Figure 38) discusses an educational strategy in which a university professor has students correct errors in essays written by ChatGPT.

Figure 38 – “Screenshot of the reality I see” 2E



Source: @filipedeschamps (2023).

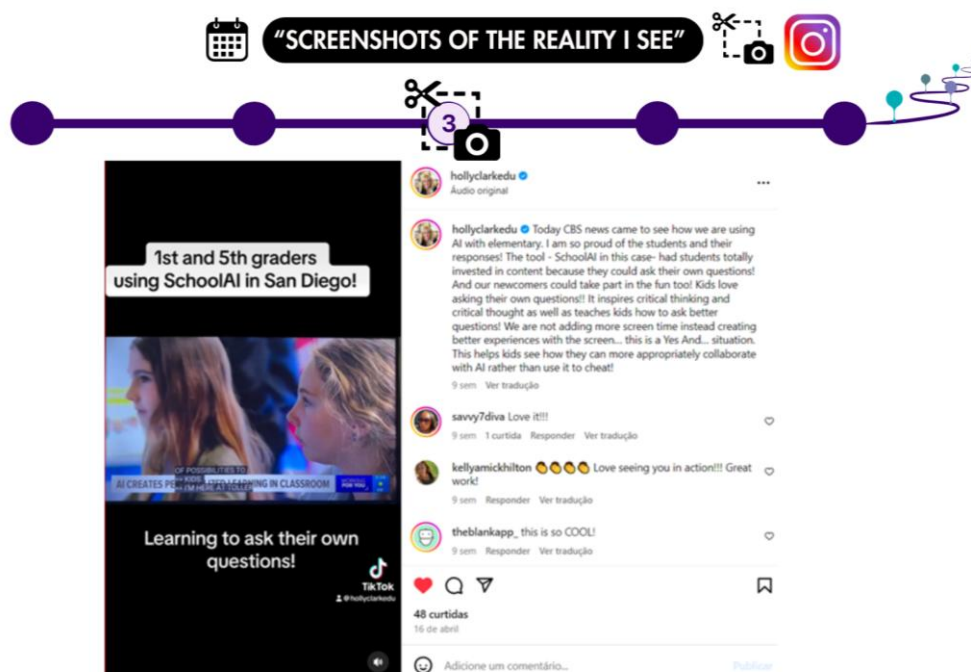
The professor's method involves having students identify and correct mistakes in texts generated by ChatGPT. As highlighted in the passage, "The publication about the case on Reddit attracted many positive comments, with users congratulating the teacher for addressing technology in a way that demonstrates the tool's limitations, as well as teaching students to better understand writing" (my translation). This strategy exposes the limitations of GenAI in writing and actively engages students in the learning process, enhancing their understanding of

writing mechanics and fostering critical thinking skills. The enthusiastic reception on Reddit underscores the potential of integrating GenAI tools in education to both challenge and educate students more effectively. Similarly, the application of these tools reflects the principles of complex systems (Morin, 2015), where interventions, such as teaching students to critically analyze AI-generated texts, initiate feedback loops that enhance learning outcomes and adapt pedagogical approaches.

The recursive nature of complex systems (Morin, 2015) makes them less predictable and controllable, as changes in one part of the system can have unforeseen effects elsewhere due to the continuous feedback loops. Unlike linear causality, which flows in one direction—from cause to effect — these systems exhibit circular causality, in which causes and effects continuously influence each other in a loop. Systems characterized by recursive thinking often involve feedback loops. Positive feedback loops can lead to exponential growth or escalation, while negative feedback loops tend to stabilize systems.

Incorporating the concept of the recursive principle (Morin, 2015) in education encourages students to think beyond linear narratives and understand the complexity and dynamism of the world around them. This principle is key in understanding complex systems in which simple cause-effect relationships are insufficient. It emphasizes the interconnectedness and interdependence of elements within a system, representing a shift from linear, compartmentalized knowledge to a more integrated, holistic understanding. Recognizing this principle allows for a deeper comprehension of the dynamic and evolving nature of complex systems. The screenshot 3E (see Figure 39) illustrates how 1st and 5th graders are using the SchoolAI tool to learn how to formulate their own questions, demonstrating a unique application of AI in educational settings.

Figure 39 – “Screenshot of the reality I see” 3E



Source: @hollyclarkedu (2024).

The initiative, highlighted by educators in San Diego (USA), leverages SchoolAI to engage students more deeply in their learning processes. The tool enables students to ask their own questions, fostering a sense of ownership and curiosity about the material. As noted in the educator’s enthusiastic feedback, “The tool —SchoolAI in this case—had students totally invested in content because they could ask their own questions!” This approach encourages critical thinking and enhances questioning skills (Freire, 1985; Freire; Faundez, 1992), and also ensures that screen time is spent on meaningful, interactive learning. It represents a step forward in utilizing technology to enrich education, promoting responsible and collaborative use of AI among young learners.

AI tools have the potential to substantially improve writing affordances and educational outcomes in academic settings by providing multifaceted support to both students and educators. LLMs, like ChatGPT, have played a crucial role in revolutionizing the process of information retrieval and comprehension, closely related to the influence exerted by Google. These tools enable users to pose questions and receive thorough explanations, thus facilitating understanding over intricate concepts (Davison et al., 2023).

Regarding these transformative shifts in multiliteracies, in which traditional and digital modalities increasingly converge, it is important to consider the evolving perceptions of more traditional practices. Reflecting on the epigraph at the beginning of this section (Dibbell, 2010),

the notion that writing by hand is seen as too slow for our times highlights a significant cultural shift. This change remains particularly profound as we continue to navigate the transition from paper to digital screens, a transformation propelled by the rise of computers and the internet. However, this transition is not experienced uniformly; many individuals and communities still lack access to computers and the internet, resulting in a growing digital divide. Advanced text-generating AI technologies are setting new standards for speed and efficiency, further widening this gap. This disparity is exacerbated by the unequal implementation of educational public policies across different countries and schools.

The transformative shifts in writing practices, as detailed in the preceding discussions, can be interpreted through the lens of Complex Thinking (Morin, 2015), aiding in understanding the reorganization processes the phenomenon of writing is undergoing. The holographic principle is evident as every part of the practices of multiliteracies (Kalantzis; Cope; Pinheiro, 2020; Kalantzis; Cope, 2023) reflects the overall cultural shift towards digital integration; small changes in classroom approaches mirror larger societal shifts towards multimodal communication. The recursive principle is observed in the iterative process of adapting literacy curricula to include traditional texts, digital content, and AI-generated content, suggesting a continual revisiting and refining of educational practices. The dialogic aspect is prominent in the engagement with multiliteracies, where texts are not merely consumed but interacted with, creating a dynamic exchange between students, educators, and digital content. Finally, the notion of a system is crucial, as literacy no longer stands alone but is interconnected with various fields such as mathematics, coding, and AI, forming an integrated network of knowledge that transcends traditional boundaries. These principles guide the understanding that writing practices are evolving into more complex, integrated systems that reflect the intricate realities of the contemporary world.

4.2 Writing processes supported by AI's automation and personalization

The theoretical construct WRITING PROCESSES SUPPORTED BY AI'S AUTOMATION AND PERSONALIZATION embodies a multifaceted approach to understanding how AI is reshaping writing practices. Central to this construct is the premise that AI's capabilities can significantly enhance writer's efficiency through the automation of assessments and personalized feedback, streamlining the writing process and potentially improving the quality of outputs. Furthermore, the use of AI tools in writing facilitates the generation of diverse and creative content, catering to a broad spectrum of writing requirements

and styles. However, this technological integration is not devoid of challenges. The detectability of AI-generated content poses significant concerns for writing assessments, complicating the ability to discern human from machine-generated text. Additionally, the use of AI in completing writing assignments introduces ethical dilemmas, particularly concerning originality and authorship. This shift suggests a transformation in the role of the writer, predominantly towards revising and editing AI-generated drafts, thereby redefining traditional writing dynamics and responsibilities.

From the perspective of Complex Thinking (Morin, 2015), this theoretical construct highlights the recursive, dialogic, and systemic nature of incorporating AI into writing. This integration demonstrates the recursive principle by showcasing how AI tools and human input continually influence and reshape each other. Writers adjust their strategies based on AI feedback, while AI systems evolve through interactions with human-generated content, creating a continuous loop of mutual enhancement and adaptation.

The dialogic principle (Morin, 2015) emerges in the exchange between technology and traditional writing practices, in which AI capabilities challenge and converse with established norms of writing and authorship. This dialogue extends to ethical considerations, as the community debates the implications of AI-generated content, reflecting on what constitutes authenticity and intellectual ownership in the “post-digital” age (Cascone, 2000; Cramer, 2015).

Furthermore, examining this construct through a systemic lens (Morin, 2015) reveals the interrelated nature of different elements such as technology, ethics, education, and societal norms. The incorporation of GenAI into writing is not an isolated phenomenon but part of a broader system that includes educational policies, technological advancements, and cultural values. Each element within this system affects and is affected by the others, indicating that changes in one aspect, like GenAI’s role in writing, could have ripple effects throughout the entire educational and social landscape. The screenshot 1D (see Figure 40) provides a visual representation of this discussion, highlighting the multifaceted roles of ChatGPT as a disruptor across various industries, including education.

Figure 40 – “Screenshot of the reality I see” 1D



<https://www.nytimes.com/2022/12/09/podcasts/hard-fork-chatgpt-openai.html?>

Can ChatGPT Make This Podcast?

OpenAI's new chatbot is a coder, a teacher, a potential Google killer, and ... a friend?

2022-12-09T05:00:06-05:00

Source: Hard Fork (2022).

In the screenshot, ChatGPT exemplifies practical applications of GenAI in the educational sector. Serving as a personalized tutoring agent, ChatGPT adapts to individual student needs, enhancing the learning experience through customized support. This LLM facilitates one-on-one tutoring tailored to the pace and preferences of students and automates assessments and feedback, significantly reducing the workload of educators. The incorporation of ChatGPT into educational practices promises to refine teaching methodologies and augment student engagement through personalized interaction and efficient evaluation processes. This application of GenAI in education illustrates the dialogic and recursive principles (Morin, 2015), as it reflects the ongoing interaction between technological innovation and conventional educational methodologies.

Similarly, the use of automation in AI-driven writing tools streamlines the writing process, echoing the efficiencies observed with ChatGPT in broader educational contexts. By reducing time and effort for content generation and editing, these tools offer significant benefits in professional and academic settings in which time constraints are critical (Borg, 2021; Davison *et al.*, 2023). This reduction in workload is crucial, particularly in the context of writing education in which developing cognitive skills such as defining goals, solving problems, and

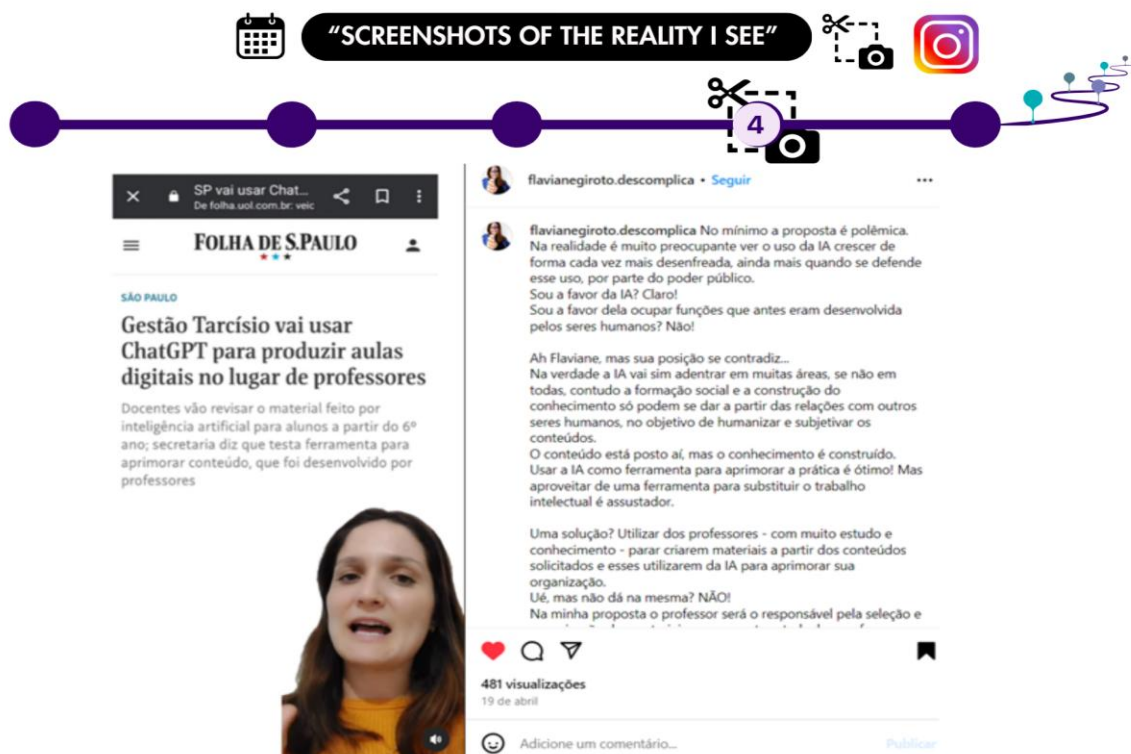
managing memory resources necessitates intensive practice and personalized feedback. The demand on teachers for preparing instructional materials, and managing the labor-intensive tasks of reading, editing, and providing feedback on student writings is significantly alleviated (Allen; Jacovina; McNamara, 2016), enabling a more focused approach to nurturing essential writing skills.

In accordance with the National Commission on Writing (2004), time for this process is rare as teachers are faced with large classes further reducing time for instruction and planning. This context justified the initial development of computer systems for summative assessment and instruction of texts, including more recent studies that seek to develop personalized guidelines for formative assessment based on individual analysis of performance and behaviors. The algorithms of these so-called W-Pal systems make use of a number of different techniques that provide personalized feedback identifying everything from more basic linguistic aspects such as word frequency, length of each sentence to features such as strategies for rhetoric, and semantic cohesion, elaboration, organization, and lexical sophistication (McNamara *et al.*, 2014). However, these systems fail to provide feedback to subjective and more significant aspects, such as students' creativity and development of ideas and arguments.

Building on these foundational AI systems, newer technologies, including AI-based Automated Writing Evaluation (AWE) systems like Grammarly, enhance writing accuracy and fluency by offering real-time feedback on grammatical errors and stylistic choices (Yan, 2023). The integration of AI tools in writing instruction also extends to the assessment phase, in which tools like ChatGPT can automatically grade written work, provide specific comments, and evaluate various aspects of the text, including content richness, clarity, and organization (Barrot, 2023). Moreover, AI tools like QuillBot are designed to bolster sentence structure and vocabulary proficiency, making them valuable for multilingual learners (Duncanson, 2024).

As AI tools become increasingly embedded in educational practices, the necessity to critically reflect on their uses is emphasized. This critical-reflective posture is advocated to comprehend the possible changes in the teaching-learning context and teaching practices brought about by algorithms designed to personalize learning, addressing each student individually (Kaufman; Santaella, 2020; Santos; Arruda, 2019). The importance of this critical examination is visually represented in the screenshot 4D (see Figure 41), which captures the reactions to Governor Tarcísio de Freitas's proposal to use ChatGPT for creating digital lessons in São Paulo's public schools.

Figure 41 – “Screenshot of the reality I see” 4D



Source: @flavianegiroto.descomplica (2024).

The approach involves using ChatGPT to develop educational content, a strategy that has stirred considerable debate about replacing some functions traditionally performed by teachers with GenAI. In this screenshot addressing this issue, concerns are voiced about the proposal being controversial and worrying: “At the very least, the proposal is controversial. In reality, it is very worrying to see the use of AI grow in this way” (my translation). This statement highlights the tension between technological advancement and the preservation of human-centered teaching practices. The discussion underscores the broader implications of AI’s role in education, emphasizing the need for a careful balance between leveraging AI for efficiency and maintaining essential human interactions that are critical for educational and social development.

The transformative potential of AI tools in educational practices extends beyond ChatGPT, encompassing their applications in lesson planning, content generation, and task creation. A conducted pedagogical experiment highlights the benefits and challenges, revealing significant advantages and drawbacks. Critically, this research assesses teachers’ competence in utilizing these tools, focusing on awareness, adaptability, and confidence. The findings indicate the need for ongoing development of digital competence among teachers and a conscious understanding of AI’s risks and limitations (Kyrpa *et al.*, 2024). The necessity for

further investigation into the educational potential of AI tools and the need to equip teachers with effective integration skills is stressed (Bazerman, 2023; Copes; Kalantziz, 2024; Kyrpa *et al.*, 2024).

Following this exploration on the impact of AI tools in education, the Complex Thinking principles (Morin, 2015) illuminate how these tools can be integrated and assessed effectively. The holographic principle is mirrored in how individual components, such as teacher competence, reflect broader educational impacts, suggesting that the effectiveness of AI tools is closely interconnected with educators' holistic understanding and implementation. The recursive nature of this approach is underscored as the study emphasizes the need for ongoing development in educators' digital competencies, fostering a continuous improvement cycle within educational practices. The dialogic principle highlights the importance of sustained dialogue among technology developers, educators, and students to ensure that AI deployments meet the diverse needs of the educational community and enhance learning outcomes. Lastly, the notion of system underscores the interconnectedness of all elements within educational ecosystems, advocating for a systemic approach to the integration of AI tools that considers all interactions between technology, pedagogical strategies, and curriculum development. These principles advocate for a multifaceted and dynamic approach to integrating AI in education (Kyrpa *et al.*, 2024).

4.3 Writing quality and authenticity in the age of AI

The theoretical construct WRITING QUALITY AND AUTHENTICITY IN THE AGE OF AI examines the dual aspects of enhancement and challenge presented by the incorporation of GenAI in writing processes. This construct highlights the concern that AI-generated content, while innovative, can sometimes lack accuracy and contain biases, potentially undermining the quality and trustworthiness of the output. It also addresses significant concerns regarding the authenticity and originality of content, crucial in maintaining the integrity of written works in academic and professional fields. Despite these obstacles, this construct acknowledges the advantages of GenAI, including its capacity to foster creativity and improve problem-solving skills through collaborative efforts with human authors. Furthermore, it underscores the necessity of writing responsibly with GenAI by understanding its limitations and potentials, suggesting that a nuanced approach can lead to significant improvements in content quality. This includes leveraging AI's advanced feedback mechanisms, which can refine content precision and effectiveness, ultimately enriching the writing process. This construct advocates

for a balanced view that embraces the technological advancements GenAI brings to writing while critically addressing its pitfalls.

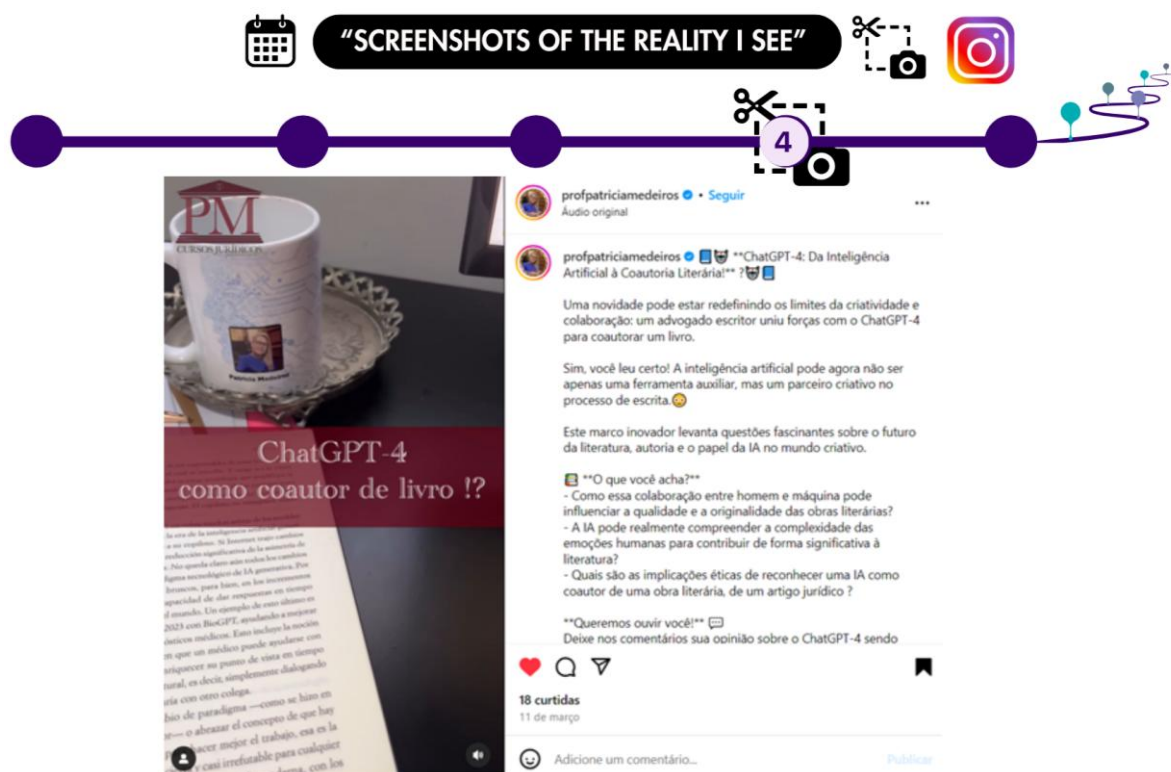
Building on this construct through the lens of Complex Thinking principles (Morin, 2015) reveals the inherently complex nature of writing systems. By applying the dialogic principle, we recognize that writing involves constant interactions between human creativity and GenAI capabilities. These elements should be integrated to enhance the depth and breadth of written content. The recursive principle further illuminates how the inputs and outputs of AI tools in writing are interdependent. Each cycle of feedback and revision potentially elevates the quality of the final product, emphasizing the recursive nature of learning and adaptation in writing.

The holographic principle suggests that every part of the writing process reflects the whole system, indicating that changes in any component — be it AI-driven grammar correction or human stylistic input — resonate throughout the entire text. Through an examination of the notion of the system, we understand that the writing is an ecosystem, that is, it is shaped by the confluence of multiple factors including technological tools, authorial purpose, and reader interpretation, all of which combine to form a dynamic and evolving narrative space. Hence, embracing these principles allows us to perceive and engage with writing not just as a linear act of producing text, but as a dynamic, interactive system that is continually shaped and reshaped by various influences.

GenAI technologies, such as grammar checkers and style editors, assist writers in producing error-free and stylistically consistent texts. These tools can identify grammatical errors, suggest vocabulary improvements, and even offer stylistic adjustments, thereby enhancing the overall quality of writing (Davison *et al.*, 2023). Moreover, AI-driven platforms can analyze large volumes of text to provide insights into writing patterns and trends, which can be particularly beneficial for academic and professional writers seeking to refine their work (Misra; Chandwar, 2023).

In terms of creativity, AI has expanded the horizons for writers by generating content ideas and even drafting initial versions of texts. This capability enables writers to explore diverse perspectives and styles, fostering more innovative and engaging content. GenAI, in particular, can simulate a variety of writing styles and genres, providing a broader palette of creative options for authors (Stokel-Walker, 2023). The screenshot 4F (see Figure 42) illustrates this point through a discussion on the use of AI in creative collaborations, particularly in the context of co-authoring books. This visualization captures the dynamic interplay between human creativity and GenAI capabilities in producing literary works.

Figure 42 – “Screenshot of the reality I see” 4F



Source: @profpatriciamedeiros (2024).

This partnership exemplifies a significant evolution in the integration of GenAI in literary creation. Highlighting the pivotal question, “How can this collaboration between human and machine influence the quality and originality of literary works?” (my translation) the conversation addresses the potential impacts of AI text generators on the quality and originality of literary works. It challenges us to consider the ethical dimensions of GenAI’s role in the creative process, questioning whether it can enhance literary output without diluting the intrinsic human qualities of emotion and personal insight that define compelling literature. This development opens a broader debate on the future of authorship and the authenticity of AI-assisted creative works.

Reflecting through the lens of Complex Thinking principles (Morin, 2015), this scenario underscores the dialogic and holographic nature of writing as a system where both human and GenAI technologies contribute to a complex creative process. Such interactions highlight the necessity of navigating these partnerships with a nuanced understanding of both the possibilities and the limitations inherent in this collaboration.

However, the use of GenAI in writing also raises questions about the authenticity of AI-generated content and the role of human creativity in writing. Beyond enhancing creative

capacities, AI significantly increases accessibility, making writing tools available to a broader audience, including non-native speakers and individuals with disabilities. Through the provision of instantaneous feedback and recommendations, AI mechanisms have the potential to assist users in refining their writing proficiencies and crafting superior quality texts, irrespective of their initial skill level (Májovský *et al.*, 2023).

The democratization of writing tools has the potential to foster a more inclusive environment in which a variety of voices are acknowledged and appreciated. Despite these benefits, the integration of AI in writing poses challenges related to ethical considerations. The employment of content generated by AI can blur the distinctions between human authorship and machine output, raising concerns about the authenticity of the written text. Readers may question whether the content reflects genuine human insight or is merely a product of algorithmic processes (Oermann; Kondziolka, 2023).

The reliance on GenAI tools could result in a standardization of writing styles, with writers possibly adhering to the recommendations offered by such tools, potentially inhibiting personal expression and originality (Dupps, 2023). Additionally, ethical considerations come to light in connection with the use of AI in writing, encompassing issues like data confidentiality, protection of intellectual property rights, and the risk of AI-generated misinformation, all of which require resolution to guarantee the suitable utilization of these technologies (Leopold *et al.*, 2023).

Furthermore, the potential for AI to perpetuate biases present in training data is a significant concern, as it can lead to biased writing outputs that reinforce existing stereotypes and inequalities (Peng; May, 2023). Through the lens of Complex Thinking (Morin, 2015), these dynamics reflect the recursive and holographic principles, in which the interaction between technology and societal norms creates a feedback loop that can either perpetuate or challenge existing disparities.

GenAI has a profound impact on contemporary writing quality, offering numerous benefits in terms of efficiency, creativity, and accessibility. Nevertheless, it also brings forth challenges concerning authenticity, ethical dilemmas, and the susceptibility to bias. In the ongoing evolution of GenAI, it is imperative for authors, academics, and decision-makers to adeptly maneuver through these intricacies to leverage the complete capabilities of AI while ensuring the preservation of the authenticity and inclusivity of human communication in written form. By embracing the dialogic, recursive, and holographic principles of Complex Thinking (Morin, 2015), stakeholders can better understand and manage the intricate relationships and impacts of AI integration in the literary field.

4.4 Writing and educational equity with AI tools

The theoretical construct of WRITING AND EDUCATIONAL EQUITY WITH AI TOOLS explores the potential of AI to foster or hinder equity in educational settings through its integration into writing practices. Central to this construct is the imperative to ensure that AI writing tools are universally accessible, thereby preventing exacerbations of existing educational inequalities. In academic contexts, the deployment of AI can be optimized through workshops and practical demonstrations, which educate and empower students and educators to effectively utilize these technologies. AI's capabilities also extend to streamlining the creation of teaching materials, significantly reducing the workload on educators and enabling more focused, personalized instruction. Collaborative writing projects, especially on a large scale, can benefit immensely from AI's organizational and generative capacities, facilitating efficient project management and execution. Moreover, while AI can serve as a catalyst for generating new ideas, maintaining academic integrity is fundamental, requiring a balanced approach to the use of AI in order to uphold the values of originality and critical thinking in writing.

Through the lens of Complex Thinking (Morin, 2015), the integration of GenAI into writing practices is perceived not simply as a technological enhancement but as a complex transformation interacting with the systemic, personal, and pedagogical dimensions of education. By invoking the holographic principle, we see that each part of the educational system reflects and contains the whole, suggesting that AI tools should be designed and implemented to mirror the entire educational ethos, including considerations of equity and accessibility. Additionally, the recursive principle underlines the ongoing feedback loops between the use of AI tools and educational outcomes, where each implementation can refine both the tools themselves and their impact on education. This perspective allows us to understand the deployment of AI in educational settings as a dynamic and evolving system, necessitating a nuanced consideration of its widespread effects on educational equity.

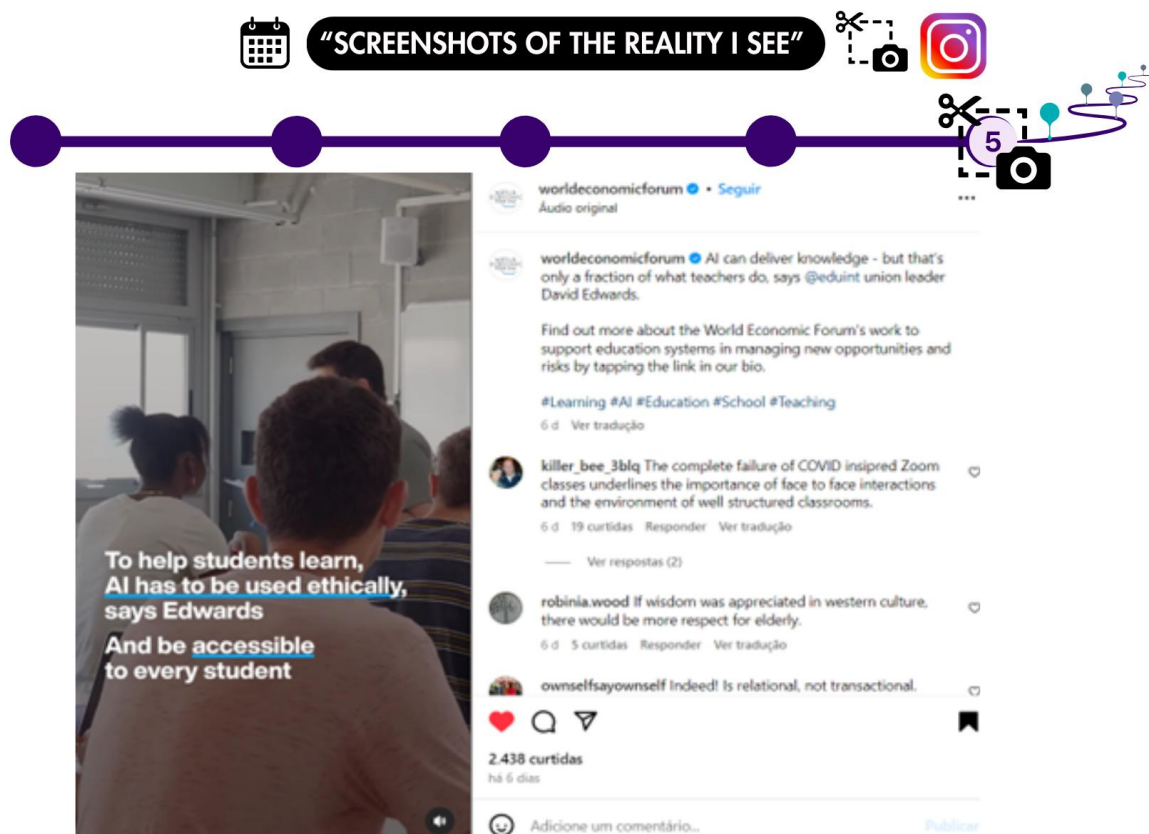
Reflecting on the ambitious potential of GenAI, critical assessments address the historical and ongoing challenges of using technology to foster educational equity (Kalantzis; Cope, 2024). Despite the widespread integration of computers in learning environments since the early 21st century, there has been little significant impact on the deep-rooted issues of educational and social inequality. Literacy, a crucial indicator and potential perpetuator of these disparities, remains an enduring challenge. This context raises crucial questions: "Can Generative AI help change the game? Can it help calibrate learning to address the great

differences between students across many dimensions? Can inexpensive, one-to-one, AI-supported literacy teaching close the gap?” (Kalantzis; Cope, 2024, p. 27).

The integration of AI writing tools in education presents both opportunities and challenges in achieving educational equity. AI writing tools possess the capacity to promote equal access to exceptional writing aid, yet they pose a potential threat of amplifying current disparities if deployed without careful consideration. These tools have the capability to enrich education through individualized guidance and assistance, a feature especially advantageous for students lacking availability to conventional tutoring services. For instance, AI can offer immediate, tailored feedback on writing assignments, helping students improve their skills at their own pace (Pan, 2024).

This capability is especially valuable in large classrooms where individual attention from instructors is limited. However, the effectiveness of AI writing tools in promoting educational equity depends significantly on their accessibility and the context in which they are used. Research indicates that disparities in access to technology can hinder the equitable distribution of AI benefits. Students from underprivileged backgrounds may lack the necessary devices or internet connectivity to fully utilize these tools, thereby widening the educational gap (Stornaiuolo *et al.*, 2023; Viberg *et al.*, 2024). The screenshot 5F (see Figure 43) highlights the integration of AI in education, focusing on its potential benefits and the ethical considerations it necessitates.

Figure 43 – “Screenshot of the reality I see” 5F



Source: @worldeconomicforum (2024).

In this screenshot, a leader in the field of education emphasizes the potential risk of AI exacerbating educational disparities, highlighting the necessity of ensuring fair distribution of AI's benefits. This emphasizes the importance of utilizing AI in a way that caters to all students, preventing the widening of current gaps. The promotion of fairness and inclusivity in educational environments through meticulous planning and policy development is crucial to guarantee that all students can access the advantages offered by AI. This concern aligns with the holographic principle (Morin, 2015), as it reflects the need for AI tools to embody the values of the entire educational system, ensuring that every part contributes to overall equity. Additionally, the dialogic principle (Morin, 2015) is evident here, as it stresses the importance of dialogue between technology and pedagogy to create an inclusive and fair educational landscape.

Moreover, the design of AI systems often reflects the biases of their creators, which can lead to biased feedback that disadvantages certain groups of students (Selim, 2024). Additionally, the incorporation of AI writing aids in academic environments necessitates a meticulous examination of instructional approaches. Educators should undergo training to

adeptly integrate these tools into their pedagogical techniques, with the aim of ensuring that they enhance rather than supplant conventional instructional approaches (Xu, 2024). This integration holds significant importance in maintaining a balanced approach that leverages the strengths of both AI and human instruction.

Another critical aspect is the potential for AI tools to support diverse learning needs. AI can be programmed to recognize and adapt to different learning styles, offering customized support that can help bridge the gap for students with varying abilities and backgrounds (Alordiah, 2023). However, this requires ongoing research and development to ensure that AI systems are inclusive and sensitive to the diverse needs of all learners. The ethical implications of AI in education also warrant attention. A necessity exists for clear and open policies concerning data privacy and the utilization of student data within artificial intelligence (AI) systems. Ensuring that students and educators understand how these tools work and the data they collect is essential for building trust and promoting equitable use (Roscoe *et al.*, 2022; Roe; Renandya; Jacobs, 2023).

While AI writing tools hold promise for enhancing educational equity, their successful implementation requires addressing issues of access, bias, and integration into existing educational frameworks. Policymakers, educators, and developers should engage in collaborative efforts to develop inclusive, accessible, and efficient AI solutions that cater to the needs of all students, especially those belonging to marginalized communities. By doing so, AI can become a powerful ally in the quest for educational equity, providing all students with the opportunity to succeed in their academic pursuits (Costa; Mfolo; Ntsobi, 2024; Gustilo; Ong; Lapinid, 2024).

For GenAI to make a substantial difference, it would require innovative pedagogical strategies and transformative changes in classroom dynamics. A scenario analysis explores both the risk of GenAI exacerbating existing inequalities and its potential to alleviate long-standing social divisions ingrained through traditional educational practices. Thus, a critical, programmatic question arises: What might an agenda of educational justice look like in a time of AI? This inquiry compels us to critically consider whether AI can be effectively utilized to promote educational equity or if it might inadvertently solidify the status quo (Kalantzis; Cope, 2024).

Viewing the challenges and potential of GenAI through the lens of Complex Thinking principles (Morin, 2015) enriches our understanding of its implications for educational equity. The holographic principle compels us to consider how AI tools could reflect and reinforce the values of equity throughout the entire educational system, rather than serving as isolated

technological fixes. Applying the recursive principle reveals the importance of iterative feedback processes in shaping the impacts of AI, ensuring that these technologies evolve in ways that genuinely support educational justice. Moreover, the dialogic principle emphasizes the need for ongoing, meaningful dialogues involving various stakeholders such as students, educators, technologists, and policymakers in order to navigate the complexities of AI incorporation and its broader societal implications. This critical examination challenges us to question not only the capabilities of AI but also the systemic changes required to ensure it benefits all learners equitably, avoiding the reinforcement of existing disparities.

4.5 Writing integrates AI while preserving human interaction

The theoretical construct of WRITING INTEGRATES AI WHILE PRESERVING HUMAN INTERACTION explores the symbiosis between AI and human involvement within the context of writing. This construct underscores that writing processes augmented by AI can significantly enhance educational experiences by offering precision and efficiency in drafting and editing, thus freeing up time for more creative and analytical pursuits. Crucially, it maintains that the integration of AI in writing education should not replace but rather complement human mentorship and interaction, ensuring that the essential elements of personal guidance and feedback remain at the forefront of the learning experience. Furthermore, employing AI in writing activities can make the learning process more engaging and enjoyable, providing a dynamic and interactive environment that caters to diverse learning styles. However, there is a critical need to strike a balance between leveraging technological advancements and retaining traditional writing methods to preserve the depth and authenticity of the educational experience. In scientific research, AI's role in assisting with drafting and editorial tasks can substantially expedite the publication process while maintaining rigorous standards of quality and accuracy.

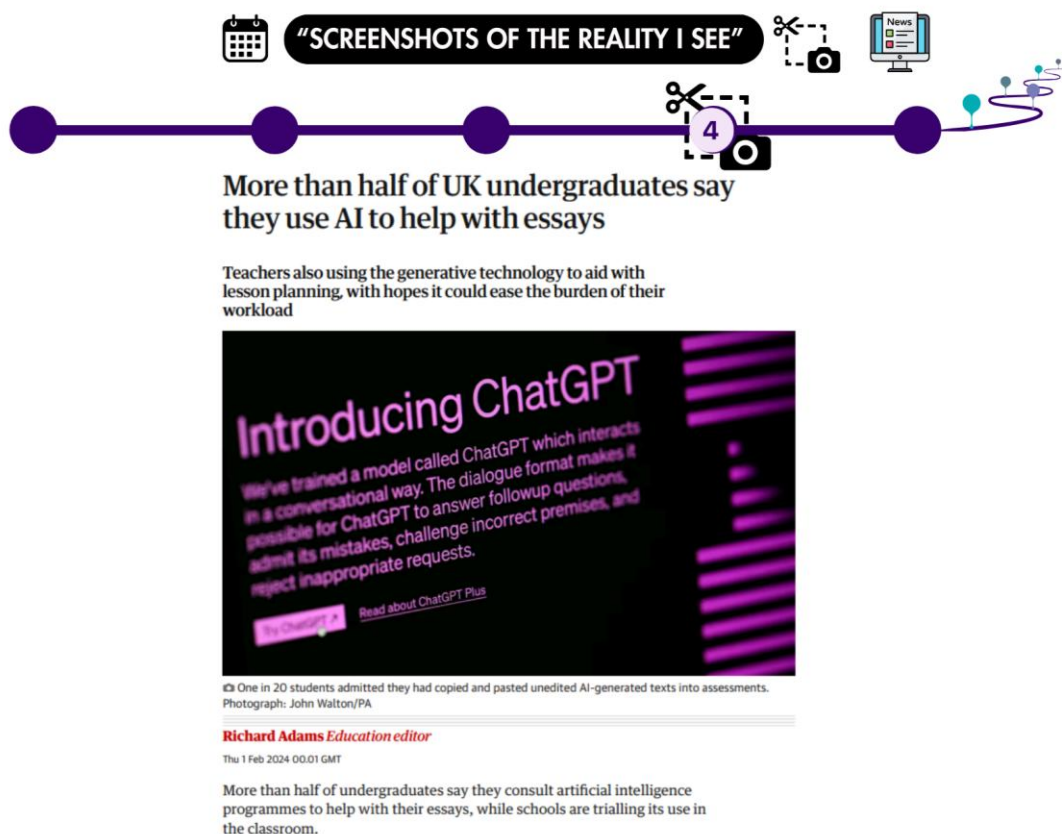
Through the lens of Complex Thinking principles (Morin, 2015), this construct explores the symbiosis between AI and human interaction within the context of writing. The dialogic principle emphasizes the continual dialogue between AI's capabilities and human creative processes, highlighting how AI can enhance the writing process by handling mechanical tasks, thereby freeing human creativity for more complex and subjective aspects of writing. The recursive principle is evident in the feedback loops between AI-enhanced tools and human

input, refining both the technology and its educational application. This interaction ensures that AI tools evolve in ways that enrich the learning experience while adhering to educational goals.

The holographic principle also plays a crucial role, suggesting that all components of the educational system—AI tools and human mentors—should reflect and contribute to the overarching educational objectives. By ensuring that AI tools complement rather than replace human interaction, the educational process retains its depth and authenticity, reflecting the comprehensive values of the system. The notion of system underscores the interconnectedness of technological and human components within the educational ecosystem. It advocates for a balanced approach to integrating AI, in which technological advancements and traditional methods coexist to enhance the educational experience, catering to diverse learning styles and needs.

Integrating AI into writing processes in educational settings offers numerous opportunities to enhance learning while preserving essential human interactions. AI systems can analyze student writing to identify areas for improvement, offering suggestions on grammar, style, and structure. This can help students develop their writing skills more effectively than traditional methods alone (Nguyen *et al.*, 2024a; Pan, 2024). Moreover, AI can facilitate the drafting process by generating ideas or providing templates, which can be particularly beneficial for students who struggle with writer's block or organizing their thoughts (Tu *et al.*, 2024). The screenshot 4D (see Figure 44) exemplifies this growing trend of AI integration in educational settings, showcasing a report on the widespread use of AI technologies for essay writing.

Figure 44 – “Screenshot of the reality I see” 4D



Source: The Guardian (2024).

The surge in AI utilization among students is underscored by a survey from the Higher Education Policy Institute, which found that “More than half of undergraduates say they consult artificial intelligence programmes to help with their essays, while schools are trialling its use in the classroom”. Furthermore, it was noted that 53% of those surveyed were actively using AI to generate content for their assignments. However, direct plagiarism appears limited, with only 5% admitting to copying and pasting unedited AI-generated text into their assessments. This highlights a shift towards using AI as a tool for enhancing academic work rather than copying from it, suggesting a need for guidelines to optimize its use responsibly within educational settings.

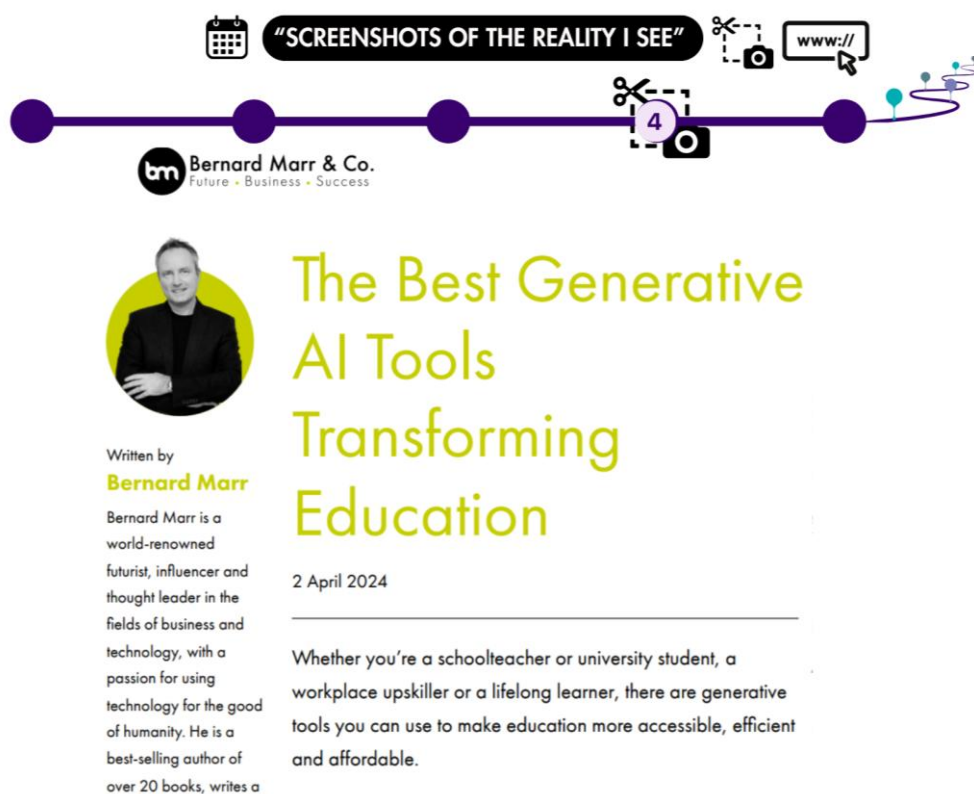
This trend underscores the dialogic principle of Complex Thinking (Morin, 2015), in which the interaction between AI tools and educational methods evolves dynamically, pointing towards a need for continuous dialogue and adaptation to ensure ethical integration and effective use within academic environments. The increasing use of AI in educational settings exemplifies a dynamic interplay between technology and educational practices. This interaction is inherently recursive (Morin, 2015). The adaptation of AI tools in learning environments

transforms student learning outcomes and necessitates ongoing adjustments in educational strategies and policies. This recursive process requires educators and policymakers to continuously evaluate and refine the implementation of AI to ensure it enhances rather than undermines educational integrity. Such a cycle promotes a holistic understanding and responsible integration of AI, aligning technological advances with the core educational values of equity and authenticity.

However, the integration of AI should be carefully managed to ensure that it complements rather than replaces human interactions. One of the key benefits of human involvement in the writing process is the ability to provide nuanced feedback that considers the emotional and contextual aspects of student work. AI systems, while efficient, may lack the ability to fully understand the subtleties of human expression and intention (Malik *et al.*, 2023; Nguyen *et al.*, 2024b). Therefore, a hybrid approach that combines AI tools with human oversight can be most effective. Teachers can use AI-generated feedback as a starting point for deeper discussions with students, fostering a more interactive and engaging learning environment (Wang, 2024).

Furthermore, AI can support collaborative writing activities by facilitating communication and coordination among students. For example, AI tools can help manage group projects by tracking contributions, suggesting edits, and ensuring that all voices are heard. This can enhance the collaborative experience and ensure that students learn from each other as well as from the AI system (Costa; Mfolo; Ntsobi, 2024; Rabbianty; Azizah; Virdyna, 2023). The screenshot 4E (see Figure 45) showcases the transformative impact of GenAI tools in education, emphasizing their potential to enhance learning experiences.

Figure 45 – “Screenshot of the reality I see” 4E



Source: Bernard Marr *et al.* (2024).

The screenshot highlights how GenAI can improve the way educational content is structured and communicated, making it more accessible and engaging for learners. “Generative AI is great for structuring and communicating information in ways that make it easy to understand and absorb as well as providing answers; it can be used to generate interactive learning experiences such as chatbots that can bring learning to life, or even roleplay as historical characters”. This approach aids in delivering information and in creating dynamic interactions that can stimulate students’ imagination and interest.

In light of Complex thinking (Morin, 2015), the use of GenAI illustrates the dialogic nature of contemporary educational resources, in which the interaction between technology and traditional educational practices creates a new and dynamic form of writing. This dialogic interaction allows GenAI tools to serve dual roles: they standardize information delivery for better understanding while simultaneously creating immersive, interactive learning modules like chatbots. This process conveys information and engages learners in a dialogue, enhancing retention and interest. The recursive aspect of GenAI in educational settings is evident as these tools learn and adapt from each interaction. As students engage with AI-driven platforms, the tools themselves evolve, continually improving their methods of information delivery and

interaction. This continuous feedback loop enriches the writing process within educational content, making it increasingly effective over time.

The holographic principle reflects how each part of the educational content — whether a structured lesson or an interactive role-play — contains the essence of the whole educational objective. GenAI integrates these various elements to create a cohesive learning experience that mirrors the complexity and interconnectedness of the subject matter being taught. GenAI's role in education exemplifies the systemic organization, in which various components of the educational system — content, pedagogy, technology, and learner engagement — are integrated. GenAI synthesizes these elements, facilitating a system that adapts to and supports diverse learning styles and needs.

Despite these advantages, there are challenges to consider. One significant concern is the potential for AI to perpetuate biases present in the data it is trained on. This can lead to biased feedback or suggestions, which could negatively impact student learning. It is crucial to develop AI systems that are transparent and regularly updated to mitigate these risks (Sysoyev; Filatov, 2024).

Additionally, there is a need for educators to be trained in effectively integrating AI tools into their teaching practices, ensuring that they can guide students in using these technologies responsibly and effectively (Rahayu *et al.*, 2023). AI can be a powerful tool in enhancing the writing process in educational settings, offering personalized feedback, facilitating collaboration, and supporting student engagement.

Considering Complex Thinking (Morin, 2015), this theoretical construct reveals the multifaceted nature of integrating GenAI in educational contexts, particularly in enhancing the writing process. It advocates for comprehensive training of educators, highlighting the need for a systemic approach to effectively harness AI's capabilities, such as providing personalized feedback, facilitating collaboration, and boosting student engagement. This perspective recognizes that the incorporation of AI tools involves more than just technical deployment; it necessitates an adaptive educational ecosystem that can foster both technological and pedagogical innovation. By emphasizing educator preparedness, this construct stresses the importance of human guidance in leveraging technological advancements, thereby balancing AI's utility with ethical considerations and educational goals. This complex interplay between human and machine illustrates the broader implications for pedagogy and curriculum development, urging a thoughtful integration of technology that enhances learning while respecting the educational guidelines.

The results from the five theoretical constructs addressed the second specific objective of this research. The key terms — enhancement, support, quality, authenticity, equity, and integration — extracted from the constructs, address educational, pedagogical, and ethical issues related to the impact of AI-text generators on the phenomenon of writing, particularly after the launch of ChatGPT. Through the lens of Complex Thinking (Morin, 2015), these terms are seen as interrelated phenomena that interact within a dynamic educational ecosystem. Collectively, they contribute to a multifaceted understanding of how AI-text generators influence writing practices. They promote enhanced pedagogical approaches and support personalized learning, while upholding quality and authenticity in written outputs. Furthermore, they advocate for educational equity by ensuring that GenAI tools are accessible and beneficial across diverse learning environments, thereby facilitating an integrated approach that respects both technological advancements and traditional educational values. This holistic view emphasizes the necessity of continuously adapting educational strategies to embrace the potentials of GenAI responsibly, ensuring that these innovations serve to augment human capabilities and foster an inclusive and effective educational landscape.

SECTION 5



FINAL REMARKS¹⁵

¹⁵ Image generated using OpenAI's DALL-E image generation tool on November 11, 2023. The prompt used for generation was: "Basing the next generation of images on these last ones*, generate an image that expresses the epistemological and methodological approach, Complex Thinking (by Edgar Morin), adopted for this investigation which focuses on education, writing, generative artificial intelligence, large language models, and ChatGPT". *One of the last images I am referring to in this prompt is the input used for the section 2 image.

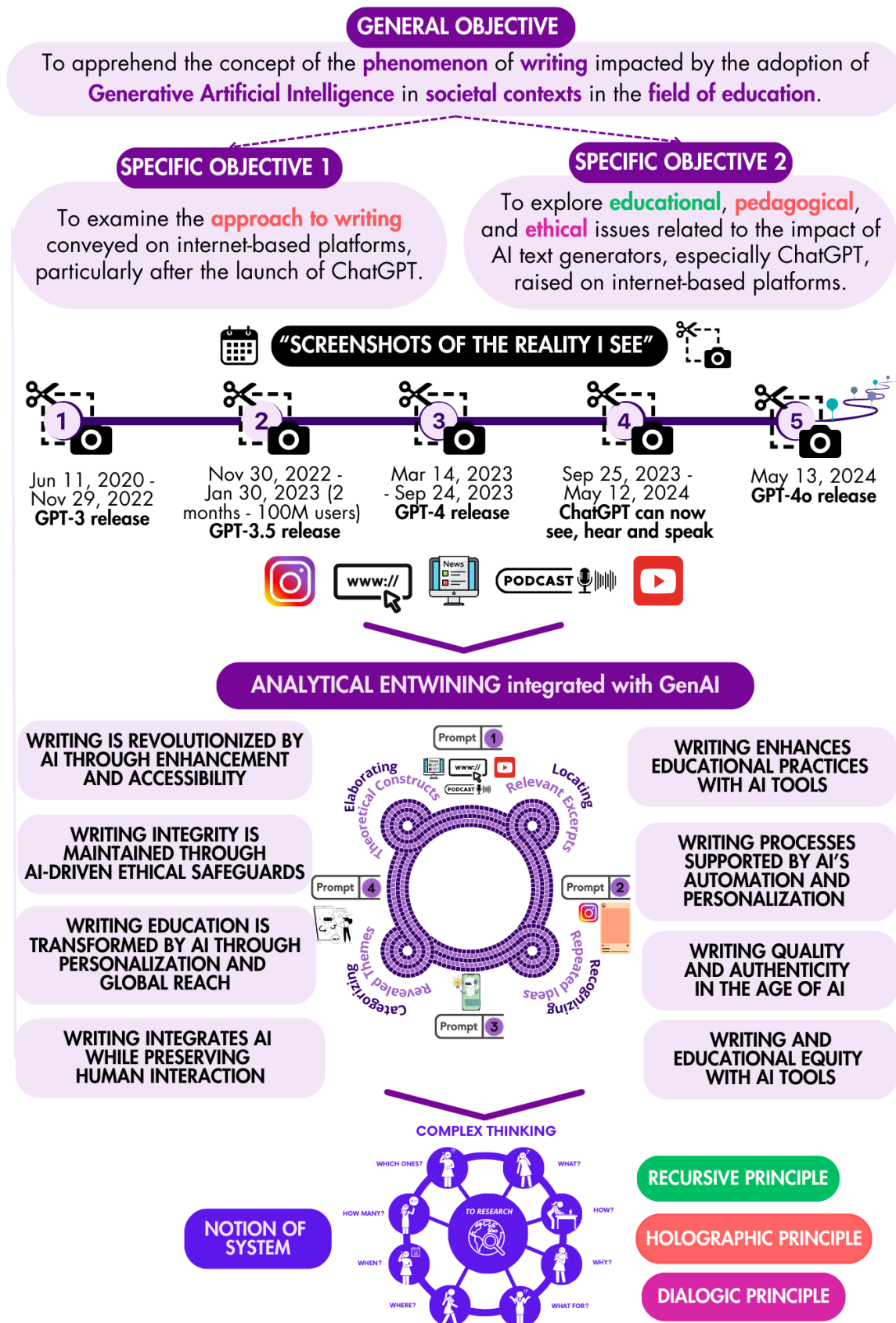
5 FINAL REMARKS

“We are not passive spectators in the history of AI, we are its authors. This means that the values that support our visions of a future with AI can become self-fulfilling prophecies”
(Lee, 2019, p. 271).

As I present these final remarks in my doctoral dissertation, I acknowledge that the scope of my research does not fully capture the complexities of the phenomena studied. In light of *Complex Thinking* (Morin, 2015), writing and GenAI technologies are considered phenomena defined as emergences (Ravagnoli, 2017). These emergences arise from the dynamic interactions among multiple system components, producing unpredictable patterns.

In this study, the phenomenon of writing is seen as a social practice, intertwined with societal aspects. I employed these types of documents — YouTube videos, podcasts, website and digital newspaper articles, and social media posts — as the strategy “screenshots of the reality I see” to illustrate the interconnectedness and impact between the phenomenon of writing and its integration with GenAI technologies. Additionally, I incorporated GenAI into my method of analysis, which not only facilitated the analytical process but also deepened my engagement with the phenomena under study. To summarize my research journey, I present the key elements that guided my methodological path (see Figure 46).

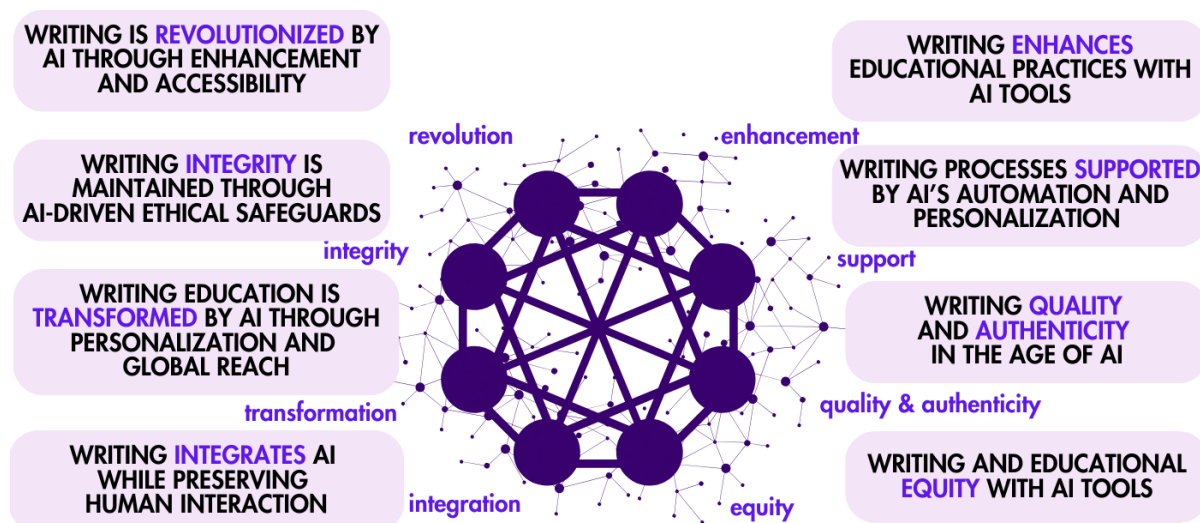
Figure 46 – My research journey



Source: created by the author (2023).

The integration of GenAI in writing, analyzed through the principles of Complex Thinking (Morin, 2015), reveals a complex interplay between technology and human agency. Both elements are in constant adaptation, influencing each other in a systemic, holographic, recursive, and dialogic manner. This interaction ensures that the writing process is dynamic, capable of evolving with technological advancements, and remains rooted in humanistic values. Utilizing the eight theoretical constructs developed in this study, I achieved the general objective of this research, which is based on the nine key words associated with these constructs (see Figure 47).

Figure 47 – The concept of writing impacted by GenAI



Source: created by the author (2023).

In the evolving educational landscape, the integration of GenAI technologies into writing practices represents a revolution by enhancing possibilities for accessibility and transforming the way we learn and create. GenAI tools ensure the integrity and authenticity of written content, providing support through personalized feedback and automated assistance, thereby transforming traditional educational approaches. These advancements enhance the learning experience by adapting to individual needs and promoting equity across diverse student populations. By integrating GenAI while preserving human creativity and interaction, we achieve a balanced and ethical approach to writing that respects the core values of education and human expression. As we move forward, it is clear that the quality of education can be enhanced by such innovative tools that bridge gaps and foster a more inclusive environment.

While the benefits of GenAI in education are substantial, they also cast a spotlight on the pressing issue of the digital divide. The lack of access to essential technologies, including computers and the internet, continues to widen this gap, particularly in various countries and schools where resources are limited. This disparity impedes the equitable distribution of educational advancements and restricts the potential for comprehensive learning and development. To ensure equitable access to the benefits of GenAI in education, the integration of these technologies requires robust measures and public policies that address existing inequalities. This approach is essential for providing every student, regardless of their geographical or economic circumstances, with equal opportunities to benefit from these transformative tools.

Moreover, the reliance on technology alone cannot guarantee the enhancement of writing quality. It is important to acknowledge that educational approaches, methods, and strategies should be grounded in core elements that prioritize long-term objectives such as critical thinking and problem-solving skills. Frequent changes in educational methodologies with every new technological innovation can be disruptive rather than beneficial. From the perspective of Complex Thinking (Morin, 2015), technologies, while powerful educational resources, are not specifically designed for learning, they emerge from and are shaped by life experience (Ravagnoli, 2017). These tools reflect and are influenced by the intentions and contexts of their users. Therefore, employing these technologies thoughtfully is essential to ensuring they serve as complements to, rather than replacements for, the fundamental educational practices that foster deep, meaningful learning.

In synthesizing these perspectives, the impact of GenAI tools on the phenomenon of writing can be meaningfully approached through the lens of Complex Thinking. This approach illuminates how these technologies, while transformative, are part of a broader ecosystem that includes socio-technical dynamics and human-centric values. The integration of GenAI into writing is not merely about automating tasks or enhancing grammatical precision; it is about enriching the writing process by fostering accessibility and addressing individual educational needs.

As evidenced by the challenges of the digital divide and model collapse (Shumailov *et al.*, 2024), these technologies also introduce complexities that should be managed with care and foresight. The influence of GenAI on writing is deeply intertwined with its ability to respect and enhance critical thinking and problem-solving, essential human cognitive capacities. Thus, while GenAI tools offer significant potential to transform educational practices, their deployment should be guided by the principles of Complex Thinking, ensuring that

technological advancements harmonize with the fundamental human aspects of learning and creativity. This balanced approach leverages the benefits of GenAI while safeguarding against its inherent risks, thereby promoting a holistic development of writing instruction in the “post-digital” age (Cascone, 2000; Cramer, 2015).

The concept of writing with GenAI support is emblematic of a complex system where various components — technology, users, educational frameworks, and ethical considerations — interact within a larger educational ecosystem. This system is not static but dynamically responds to changes within each component, affecting how writing is taught, learned, and practiced across different contexts. In light of the ongoing debates surrounding technologies in education, particularly AI-text generators and, more recently, the banning of smartphones in schools, it is essential for educators and teacher educators to embrace an active, critical, and reflective approach to writing instruction.

Educators can guide learners in harnessing the potential of these technologies by fostering critical GenAI-supported multiliteracies and encouraging thoughtful integration of AI-text generators. A key strategy is the effective and ethical construction of prompts to enhance writing instruction. Thoughtfully designed, purpose-driven prompts can support students in exploring their creativity, critical thinking, and problem-solving skills. Moreover, prompt crafting serves as a practical approach to teaching with GenAI and an ethical means of promoting learner autonomy in writing. It also cultivates an awareness of how to use GenAI platforms responsibly in educational contexts. Integrating GenAI into curricula requires thoughtful application and a critical examination of its implications to ensure it enhances, rather than overshadows, the core values of writing as a complex phenomenon within an interconnected ecosystem.

Recognizing writing as part of this evolving system broadens our understanding of its multifaceted nature and challenges traditional views of writing as a static skill or mechanical ability. This research introduces the concept of writing as an ecosystem, in which technology and human elements are interdependent and mutually enhancing, contributing to a more collaborative and adaptive approach to writing instruction. This reorganization embodies a continuous interplay between technology and tradition, ensuring that the evolution of writing practices through GenAI enriches, rather than diminishes, the educational experience.

REFERENCES

- ABURASS, Sanad; ABU RUMMAN, Maha. Authenticity in authorship: the writer's integrity framework for verifying human-generated text. **Research Square**, 2024. DOI: 10.21203/rs.3.rs-4259560/v1. Accessed on: 15 June 2024.
- AFIFAH. Preserving academic integrity in the age of AI. In: THE ASIAN CONFERENCE ON EDUCATION & INTERNATIONAL DEVELOPMENT, 2024. **Official conference proceedings**. ISSN: 2189-101X. Available at: <https://doi.org/10.22492/issn.2189-101X.2024.20>. Accessed on: 11 June 2024.
- AHMAD, Norita; MURUGESAN, San; KSHETRI, Nir. Generative artificial intelligence and the education sector. **IEEE Computer Society**, v. 55, n. 10, p. 72-76, 2023. Available at: <https://doi.org/10.1109/MC.2023.3263576>. Accessed on: 19 June 2024.
- AKRAM, Arslan. An empirical study of AI generated text detection tools. **arXiv.org**, v. abs/2310.01423, 26 Sep. 2023. Available at: <https://arxiv.org/abs/2310.01423>. Accessed on: 4 Aug. 2024.
- ALLEN, Laura K.; JACOVINA, Matthew E.; MCNAMARA, Danielle S. Computer-based writing instruction. In: MACARTHUR, Charles A.; GRAHAM, Steve; FITZGERALD, Jill (orgs.). **Handbook of writing research**. New York, NY: The Guilford Press, 2016. p. 347-351.
- ALORDIAH, Caroline Ochuko. Appreciating the AI revolution: empowering educational researchers through AI tools for writing research articles. **Zamfara International Journal of Humanities**, v. 2, n. 01, p. 178-195, 2023. DOI: 10.36349/zamijoh.2023.v02i01.013.
- ATKINSON, Paul; BARKER, Richie. AI and the social construction of creativity. **Convergence**, v. 29, n. 4, 05 July 2023. DOI: 10.1177/13548565231187730.
- AUERBACH, Carl; SILVERSTEIN, Louise B. **Qualitative data: an introduction to coding and analysis**. New York: New York University, 2003.
- BARROT, Jessie S. Using ChatGPT for second language writing: pitfalls and potentials. **Assessing Writing**, v. 57, 2023, p. 100745. Available at: <https://doi.org/10.1016/j.asw.2023.100745>. Accessed on: 4 Aug. 2024.
- BAZERMAN, Charles. What do sociocultural studies of writing tell us about learning to write? In: MACARTHUR, Charles A.; GRAHAM, Steve; FITZGERALD, Jill (orgs.). **Handbook of writing research**. New York, NY: The Guilford Press, 2016. p. 17-31.
- BENGIO, Yoshua; DUCHARME, Réjean; VINCENT, Pascal; JAUVIN, Christian. A neural probabilistic language model. **Journal of Machine Learning Research**, v. 3, p. 1137-1155, 2003. DOI: 10.1162/jmlr.2003.3.1.1137.
- BENZON, William. GPT-3: Waterloo or rubicon? Here be Dragons. **Cognitive and Neuroscience**, Ago. 2020. Available at: https://www.researchgate.net/publication/343444766_GPT-3_Waterloo_or_Rubicon_Here_be_Dragons. Accessed on: 6 Oct. 2020.

BOA SORTE, Paulo. Internet memes: classroom perspectives in the context of digital cultures. **Educação e Formação**, Fortaleza, v. 4, n. 12, p. 51-66, Sept.-Oct. 2019.

BOA SORTE, Paulo. Remixes e expressão escrita em língua inglesa. In: JORDÃO, C. M.; MARTINEZ, J. Z.; MONTE MÓR, W. (orgs.). **Letramentos em prática na formação inicial de professores de inglês**. Campinas, SP: Pontes Editores, 2018. p. 279-292.

BOA SORTE, Paulo; SANTOS, Jefferson do Carmo Andrade. Memes em aulas de língua inglesa: explorando práticas de multiletramentos. **Revista Educação em Questão**, Natal, v. 58, n. 55, p. 1-19, Jan.-Mar. 2020.

BOA SORTE, Paulo; FARIAS, Mário André de Freitas; DOS SANTOS, Allessandra Elisabeth; SANTOS, Jefferson do Carmo Andrade; DIAS, Jamile Santos dos Santos Rodrigues. Artificial intelligence in academic writing: what is in store with the GPT3 algorithm? **Revista EntreLínguas**, Araraquara, v. 7, n. 00, p. e021035, 2021. e-ISSN: 2447-3529. Available at: <https://periodicos.fclar.unesp.br/entrelinguas/article/view/15352/11410>.

BOA SORTE, Paulo; SANTOS, Jefferson do Carmo Andrade; DOS SANTOS, Allessandra Elisabeth; SILVA, Laila Gardênia Viana. SILVA, Nayara Stefanie Mandarino. Entrelace analítico como metodologia de pesquisa em educação no paradigma emergente. **Revista Educação em Páginas**, Vitória da Conquista, v. 02, p. e13531, 2023. <https://periodicos2.uesb.br/index.php/redupa/article/view/13531>.

BODEN, M. A. **Inteligência artificial**: uma brevíssima introdução. São Paulo: Editora Unesp, 2020. 250 p.

BORG, Jana Schaich. Four investment areas for ethical AI: transdisciplinary opportunities to close the publication-to-practice gap. *Big Data & Society*, v. 8, n. 2, 2021. DOI: 10.1177/20539517211040197.

BRASIL. **Lei nº 9.279, de 14 de maio de 1996**. Regula direitos e obrigações relativos à propriedade intelectual. Brasília, DF: Presidência da República, 1996. Available at: http://www.planalto.gov.br/ccivil_03/leis/l9279.htm.

BRASIL. **Lei nº 9.610, de 19 de fevereiro de 1998**. Altera, atualiza e consolida a legislação sobre direitos autorais e dá outras providências. Brasília, DF: Presidência da República, 1998. Available at: http://www.planalto.gov.br/ccivil_03/leis/l9610.htm

BREMMER, Ian; STELTER, Brian; HEMMER, Nicole. Will AI influence the 2024 US election? **GZERO World**, 2023. Video (3:48 min). Available at: <https://www.youtube.com/watch?v=jJ6SA9AwB-I&t=24s>. Accessed on: 10 November 2023.

BURWELL, Catherine. The pedagogical potential of video remix: critical conversations about culture, creativity and copyright. **Journal of Adolescent & Adult Literacy**, v. 57, n. 3, p. 205-213, Nov. 2013.

BUZAN, Tony. The history of mind mapping. **Mind-Map - The World of Mind Mapping**, 2024. Available at: <https://mind-map.com/history/>. Accessed on: 11 July 2024.

CASANAVE, Christine Pearson. Performing expertise in doctoral dissertations: thoughts on a fundamental dilemma facing doctoral students and their supervisors. **Journal of Second Language Writing**, v. 43, n. 1, p. 57-62, 2019.

CASCONI, Kim. The aesthetics of failure: “post-digital” tendencies in contemporary computer music. **Computer Music Journal**, Winter, Massachusetts Institute of Technology, v. 4, n. 24 p. 12-18, 2000.

CHAKRABORTY, Utsho; GHEEWALA, Jaydeep; DEGADWALA, Sheshang; VYAS, Dhairya; SONI, Mukesh. Safeguarding authenticity in text with BERT-powered detection of AI-generated content. In: INTERNATIONAL CONFERENCE ON INVENTIVE COMPUTATION TECHNOLOGIES (ICICT), 7., 2024, Lalitpur, Nepal. **Proceedings [...]**. Xplore Part Number: CFP24F70-ART; ISBN: 979-8-3503-5929-9. [S. l.: s. n.], 2024. p. 34-37. DOI: 10.1109/ICICT60155.2024.10544590.

CHRISTENSEN, Clayton. M. **O dilema da inovação**: quando as novas tecnologias levam empresas ao fracasso. São Paulo: M. Books do Brasil, 2012.

COPE, Bill; Kalantzis, Mary; Sears Smith, Duane. Artificial intelligence for education: knowledge and its assessment in AI-enabled learning ecologies. **Educational, Philosophy and Theory**, p. 1-17, 2020. Available at: <https://doi.org/10.1080/00131857.2020.1728732>.

COSTA, King; MFOLO, Letlhogonolo Nolo; NTSOBI, Mfanelo Patrick. Challenges, benefits and recommendations for using generative artificial intelligence in academic writing – a case of ChatGPT. **MetaArXiv Preprints**, 2024. DOI: 10.31222/osf.io/7hr5v. Available at: <https://osf.io/7hr5v>. Accessed on: 11 Aug. 2024.

CRAMER, Florian. What is “post-digital”? In: BERRY, D.; DIETER, M. (ed.). **Post-digital aesthetics**: art, computation and design. New York, NY: Palgrave Macmillan, 2015.

ČRČEK, N.; PATEKAR, J. Writing with AI: university students’ use of ChatGPT. **Journal of Language and Education**, v. 9, n. 4, p. 128-138, 2023. Available at: <https://doi.org/10.17323/jle.2023.17379>. Accessed on: 4 Aug. 2024.

CROMPTON, Helen; BURKE, Diane. Artificial intelligence in higher education: the state of the field. **International Journal of Educational Technology in Higher Education**, v. 20, n. 1, p. 1-22, 2023. DOI: 10.1186/s41239-023-00392-8.

DAVISON, R. M.; LAUMER, S.; TARAFDAR, M.; WONG, L. H. M. Pickled eggs: generative AI as research assistant or co-author? **Information Systems Journal**, v. 33, p. 989-994, 2023. DOI: 10.1111/isj.12455.

DAWOOD, Mina Eshaq Tawfilis. Using artificial intelligence for enhancing human creativity. **Journal of Art, Design and Music**, 28 June 2023.

DE OLIVEIRA, Luciana C.; SILVA, Tony. Second language writing in elementary classrooms: an overview of issues. In: DE OLIVEIRA, L. C.; SILVA, T. (ed.). **Second language writing in elementary classrooms**: instructional issues, content-area writing, and teacher education. New York, NY: Palgrave Macmillan, 2016. p. 1-10.

DIBBELL, Julian (ed.). **The best technology writing 2010**. New Haven: Yale University Press, 2010. 288 p.

DONG, Yifan. Revolutionizing academic English writing through AI-powered pedagogy: practical exploration of teaching process and assessment. **Journal of Higher Education Research**, Dalian, v. 4, n. 2, p. 52-57, 2023. DOI: 10.32629/jher.v4i2.1188.

DOS SANTOS, Allessandra Elisabeth. Representações de professoras de inglês sobre tecnologias e sua relação com a prática docente. 2020. Dissertação (Mestrado em Educação) – Universidade Federal de Sergipe, São Cristóvão, 2020.

DOS SANTOS, Allessandra Elisabeth; OLESOVA, Larisa; VICENTINI, Cristiane; DE OLIVEIRA, Luciana C. ChatGPT in ELT: writing affordances and activities. **TESOL Connections**, May 2023.

<https://tcnewsletter.s3.amazonaws.com/newsmanager.commpartners.com/tesolc/issues/2023-05-01/2.html>.

DOS SANTOS, Allessandra Elisabeth; SILVA, Laila Gardênia Viana; SIQUEIRA, Nadege Ramalho de. ChatGPT e implicações na educação: o cenário da escrita acadêmica. In: PORTO, Cristiane; CHAGAS, Alexandre; OLIVEIRA, Kaio Eduardo (org.). **Educiber: educação e divulgação científica em plataformas digitais**. 1. ed. Aracaju: Edunit, 2023, v. 5, p. 204-222. <https://editoratiradentes.com.br/wp-content/uploads/2023/08/Educiber-5-Final.pdf>.

DOUNG, Michael Tran; RAUSCHECKER, Andreas M.; MOHAN, Suyash. Diverse applications of artificial intelligence in neuroradiology. **Neuroimag Clin N Am**, v. 30, n. 4, p. 505-516, Sept. 2020. Available at: <https://doi.org/10.1016/j.nic.2020.07.003>. Accessed on: 12 Nov. 2020.

DUNCANSON, Julia. Supporting L2 writing using QuillBot. **GATESOL Journal**, v. 33, n. 1, p. 30-36, 2024. ISSN: 2331-6845. Available at: <https://doi.org/10.52242/gatesol.195>. Accessed on: 4 Aug. 2024.

DUPPS, William J. Artificial intelligence and academic publishing. **Journal of Cataract and Refractive Surgery**, v. 49, n. 7, p. 655-656, 2023. DOI: 10.1097/J.JCRS.0000000000001223.

ELLAWAY, Rachel; TOLSGAARD, Martin. Artificial scholarship: LLMs in health professions education research. **Advances in Health Sciences Education**, v. 28, p. 659-664, 2023. DOI: 10.1007/s10459-023-10257-4.

ELLIS, Amanda R.; SLADE, Emily. A new era of learning: considerations for ChatGPT as a tool to enhance statistics and data science education. **Journal of Statistics and Data Science Education**, v. 31, p. 128-133, 2023. DOI: 10.1080/26939169.2023.2223609.

ELSEN-ROONEY, Michael. NYC education department blocks ChatGPT on school devices, networks. **Chalkbeat**, Jan. 3, 2023. Available at:

[https://www.chalkbeat.org/newyork/2023/1/3/23537987/nyc-schools-ban-chatgpt-writing-artificial-](https://www.chalkbeat.org/newyork/2023/1/3/23537987/nyc-schools-ban-chatgpt-writing-artificial-intelligence/#:~:text=%E2%80%9CDue%20to%20concerns%20about%20negative,education%20department%20spokesperson%20Jenna%20Lyle)

[intelligence/#:~:text=%E2%80%9CDue%20to%20concerns%20about%20negative,education%20department%20spokesperson%20Jenna%20Lyle](https://www.chalkbeat.org/newyork/2023/1/3/23537987/nyc-schools-ban-chatgpt-writing-artificial-intelligence/#:~:text=%E2%80%9CDue%20to%20concerns%20about%20negative,education%20department%20spokesperson%20Jenna%20Lyle). Accessed on: 16 Oct. 2023.

EWE, Koh. The ultimate election year: all the elections around the world in 2024. **Time**, Dec. 28, 2023. Available at: <https://time.com/6550920/world-elections-2024/>. Accessed on: 15 June 2024.

FACHIN: ‘É HORA DE DIZER BASTA À DESINFORMAÇÃO E AO POPULISMO AUTORITÁRIO’. **RBA _Rede Brasil Atual**, 18 July 2022. Politics. Available at:

<https://www.redebrasilatual.com.br/politica/fachin-dizer-basta-a-desinformacao-popularismo-autoritario/>. Accessed on: 15 Sept. 2023.

FERRARI, Fabricio; CECHINEL, Cristian. **Introdução a algoritmos e programação**. Material didático e instrucional. Porto Alegre, Rio Grande do Sul: [s. n.], 2008.

FISCHER, Steven Roger. **A history of writing**. London: Reaktion Books, 2021. 392 p.

FLORIDA, Richard L. **The rise of the creative class revisited**. New York: Basic Books, 2012.

FREEMAN, Donald. **Doing teacher-research: from inquiry to understanding**. Canada: Heinle & Heinle Publishers, 1998.

FREIRE, Paulo. **Educação como prática da liberdade**. [Education as the practice of freedom]. São Paulo: Paz e Terra, 1985.

FREIRE, Paulo; FAUNDEZ, Antonop. **Por uma pedagogia da pergunta**. [Toward a pedagogy of the question]. São Paulo: Paz e Terra, 1992.

GIL, Antonio C. Como classificar as pesquisas? In: GIL, A. **Como elaborar projetos de pesquisa**. 4. ed. Atlas: São Paulo, 2002. Cap. 4, p. 42-50.

GILBERT, Iona. A machine in the loop: the peculiar intervention of artificial intelligence in writer's block. **New Writing**, 21 June 2023. p. 1-12. DOI: 10.1080/14790726.2023.2223176.

GLOBO. Canadense usa inteligência artificial para simular troca de mensagens com noiva morta há 8 anos. In: **Fantástico**. [S. l.], 26 Sept. 2021. video (12m 12s). Available at: <https://g1.globo.com/fantastico/noticia/2021/09/26/canadense-usa-inteligencia-artificial-para-simular-troca-de-mensagens-com-noiva-morta-ha-8-anos.ghtml>. Accessed on: 10 Jan. 2022.

GORDON, Andrew D.; NEGREANU, Carina; CAMBRONERO, José Pablo; CHAKRAVARTHY, Rasika; DROSOS, Ian; FANG, Hao; MITRA, Bhaskar; RICHARDSON, Hannah; SARKAR, Advait; SIMMONS, Stephanie; WILLIAMS, Jack; ZORN, Ben. Co-audit: tools to help humans double-check AI-generated content. **arXiv.org**, v. abs/2310.01297, 01 Oct. 2023. Available at: <https://arxiv.org/abs/2310.01297>. Accessed on: 10 Dec. 2023.

GUANGMING, Zhu *et al.* Artificial intelligence and stroke imaging: a west coast perspective. **Neuroimag Clin N Am**, v. 30, n. 4, p. 479-492, Nov. 2020. Available at: <https://doi.org/10.1016/j.nic.2020.07.001>. Accessed on: 11 Nov. 2020.

GUI, Jia; DOS SANTOS, Allessandra Elisabeth. Genre-based pedagogy in English language arts integrated with generative artificial intelligence. In: DE OLIVEIRA, L. C. (ed.). **Applying a functional approach to language development in teaching the content areas to multilingual learners in K-12 classrooms**. Charlotte, NC: Information Age Publishing. Forthcoming.

GUPTA, Rajiv *et al.* An east coast perspective on artificial intelligence and machine learning: part 1: hemorrhagic stroke imaging and triage. **Neuroimag Clin N Am**, v. 30, n. 4, p. 479-492, Nov. 2020. Available at: <http://dx.doi.org/10.1016/j.nic.2020.08.002>. Accessed on: 11 Nov. 2020.

GUSTILO, Leah; ONG, Ethel; LAPINID, Minie Rose C. Algorithmically-driven writing and academic integrity: exploring educators' practices, perceptions, and policies in AI era.

International Journal for Educational Integrity, v. 20, p. 1-43, 2024. DOI: 10.1007/s40979-024-00153-8.

HIGGINS, Eliot. Trump's image arrest. 2023. Twitter: @eliothiggins. Available at: <https://twitter.com/EliotHiggins/status/1637927681734987777>. Accessed on: 10 Nov. 2023.

HOSSEINI, Mohammad; RESNIK, David B. Guidance needed for using artificial intelligence to screen journal submissions for misconduct. **Research Ethics**, OnlineFirst, 2024. DOI: 10.1177/17470161241254052.

JACOB, Sharin; TATE, Tamara P.; WARSCHAUER, Mark. Emergent AI-assisted discourse: case study of a second language writer authoring with ChatGPT. **arXiv.org**, v. abs/2310.10903, 16 Oct. 2023. Available at: <https://arxiv.org/abs/2310.10903>.

JEANTET, Diane. Brazilian voters bombarded with misinformation before vote. **AP News headline**, 25 Oct. 2022. Available at: <https://apnews.com/article/jair-bolsonaro-caribbean-social-media-brazil-b75e51f515b0a708800198afa1b8601d>. Accessed on: 13 July 2023.

KALANTZIS, Mary; COPE, Bill. Literacy in the time of artificial intelligence. **EdArXiv Preprints**, Apr. 2024. DOI: 10.35542/osf.io/es5kb. Available at: <https://osf.io/es5kb>. Accessed on: 10 May 2024.

KALANTZIS, Mary; COPE, Bill. Multiliteracies: a short update. **International Journal of Literacies**, v. 30, n. 2, p. 1-15, 2023. DOI: 10.18848/2327-0136/CGP/v30i02/1-15.

KALANTZIS, Mary; COPE, Bill; PINHEIRO, Petrilson. **Letramentos**. Campinas, SP: Editora da Unicamp, 2020. 408 p.

KAMMER, Michael N.; GOMILA, Paul; VUMBACO, David J.; MALDONADO, Fabien. The role of artificial intelligence in scientific writing. **Journal of Clinical Case Reports Medical**, 16 Feb. 2023. Available at: <https://jmedcasereportsimages.org/jcrmhs-v3-1116/>.

KAUFMAN, Dora. **A inteligência artificial irá suplantar a inteligência humana?** Barueri, SP: Estação das Letras e Cores, 2019. 94 p.

KAUFMAN, Dora; SANTAELLA, Lucia. O papel dos algoritmos de inteligência artificial nas redes sociais. **Revista Famecos**, Porto Alegre, v. 27, p. 1-10, Jan.-Dec. 2020.

KIST, William. **New literacies in action: teaching and learning in multiple media**. New York: Teachers College Press, 2005.

KNOBEL, Michele. Imagining beyond the domesticated “new”: creative remixings of literacies, community, and place. An analytic review of the research literature. In: LITERACY RESEARCH ASSOCIATION CONFERENCE SYMPOSIUM, 4 Dec. 2015.

KYRPA, Anna; STEPANENKO, Olena; ZINCHENKO, Viktoriia; DATSIUK, Tetiana; KARPAN, Iryna; TILNIAK, Neonila. Artificial intelligence tools in teaching social and humanitarian disciplines. **Information Technologies and Learning Tools**, v. 100, n. 2, p. 162-179, 2024. DOI: 10.33407/itlt.v100i2.5563. Available at: <https://journal.iitta.gov.ua/index.php/itlt/article/view/5563>. Accessed on: 4 Aug. 2024.

LANCASTER, Thomas. Artificial intelligence, text generation tools and ChatGPT – does digital watermarking offer a solution? **International Journal for Educational Integrity**, v. 19, n. 10, 2023. Available at: <https://doi.org/10.1007/s40979-023-00131-6>. Accessed on: 19 June 2024.

LEE, Kai-Fu. **Inteligência artificial**: como os robôs estão mudando a forma como amamos, nos relacionamos, trabalhamos e vivemos. Tradução de Marcelo Barbão. Rio de Janeiro: Globo Livros, 2019. 290 p.

LEMOS, André. **Cibercultura**: tecnologia e vida social na cultura contemporânea. 6. ed. Porto Alegre: Sulina, 2013.

LEOPOLD, Seth S.; HADDAD, Fares S.; SANDELL, Linda J.; SWIONTKOWSKI, Marc. Artificial intelligence applications and scholarly publication in orthopaedic surgery. **The Journal of Bone and Joint Surgery**, v. 105, n. 11, p. 819-820, 7 June 2023. DOI: 10.2106/JBJS.23.00293.

LEU, Donald J.; SLOMP, David; ZAWILINSKI, Lisa; CORRIGAN, Julie A. Writing research through a news literacies lens. In: MACARTHUR, C. A.; GRAHAM, S.; FITZGERALD, J. (orgs.). **Handbook of writing research**. New York, NY: The Guilford Press, 2016. p. 49-63.

LI, Xiaolian; ZHANG, Bo. AI poem case analysis: take ancient Chinese poems as an example. In: CAIH2020: **Proceedings of the 2020 Conference on Artificial Intelligence and Healthcare**, 4 Dec. 2020. p. 132-136. DOI: 10.1145/3433996.3434020.

LUCENA, Simone; SANTOS, Edméa. APP-DIÁRIO na formação de pesquisadores em Programa de Pós-Graduação em Educação. **Educação Unisinos**, v. 24, n. 4, p. 658-671, Oct.-Dec. 2019. Available at: <https://doi.org/10.4013/edu.2019.234.18162>.

LÜDKE, Menga; ANDRÉ, Marli E. D. A. **Pesquisa em educação**: abordagens qualitativas. São Paulo: Ed. Pedagógica e Universitária, 1986. Cap. 2, 3, p. 11-44.

LUKIANENKO, Valentyna Volodymyrivna; SHASTKO, Iryna Myronivna; KORBUT, Oksana Hryhorivna. Evaluating AI detection tools for academic integrity in higher education. **Scientific Innovations and Advanced Technologies**, v. 5, n. 33, 2024, p. 970-978. DOI: 10.52058/2786-5274-2024-5(33)-970-978.

MÁJOVSKÝ, Martin; KASAL, Matěj; KOMARC, Martin; NETUKA, David. Artificial intelligence can generate fraudulent but authentic-looking scientific medical articles: Pandora's box has been opened. **Journal of Medical Internet Research**, v. 25, p. e46924, 2023. DOI: 10.2196/46924.

MALEKI *et al.* Machine learning algorithm validation: from essentials to advanced applications and implications for regulatory certification and deployment. **Neuroimag Clin N Am**, v. 30, n. 4, p. 433-445, Nov. 2020. Available at: <https://doi.org/10.1016/j.nic.2020.08.004>. Accessed on: 12 Nov. 2020.

MALIK, Agung Rinaldy; PRATIWI, Yuni; ANDAJANI, Kusubakti; NUMERTAYASA, I. W.; SUHARTI, Sri; DARWIS, Arisa; MARZUKI. Exploring artificial intelligence in academic essay: higher education student's perspective. **International Journal of Educational Research Open**, 2023. DOI: 10.1016/j.ijedro.2023.100296.

MCINTYRE, Lee. **Post-truth**. Cambridge, MA: MIT Press, 2018.

MCNAMARA *et al.* **Automated evaluation of text and discourse with Coh-Metrix**. Cambridge, UK: Cambridge University Press, 2014.

MISRA, Durga Prasanna; CHANDWAR, Kunal. ChatGPT, artificial intelligence and scientific writing: what authors, peer reviewers and editors should know. **Journal of the Royal College of Physicians of Edinburgh**, v. 53, p. 90-93, 2023. DOI: 10.1177/14782715231181023.

MORIN, Edgar. Da necessidade de um pensamento complexo. In: MARTINS, Francisco Menezes; SILVA, Juremir Machado da (orgs.). **Para navegar no século XXI: tecnologias do imaginário e cibercultura**. 2. ed. Porto Alegre, RS: Sulina/Edipucrs, 2000. p. 19-42.

MORIN, Edgar. **Introdução ao pensamento complexo**. 5. ed. Porto Alegre: Sulina, 2015. 120 p.

MORIN, Edgar; ROGER-CIURANA, Emilio; MOTTA, Raul Domingo. **Educar na era planetária**. Barcelona: Gedisa, 2003. 111 p.

MOURA, Francisco T. Artificial intelligence, creativity, and intentionality: the need for a paradigm shift. **Journal of Creative Behavior**, v. 57, p. 336-338, 2023. DOI: 10.1002/jocb.585.

MUTHUKRISHNAN, Nikesh *et al.* Brief history of artificial intelligence. **Neuroimaging Clinics of North America**, v. 30, n. 4, p. 393-399, Nov. 2018. Available at: <https://doi.org/10.1016/j.nic.2020.07.004>. Accessed on: 11 Nov. 2020.

NEGUS, Keith; PICKERING, Michael. **Creativity, communication and cultural value**. London: Sage, 2004.

NGUYEN, Andy; HONG, Yvonne; DANG, Belle; HUANG, Xiaoshan. Human-AI collaboration patterns in AI-assisted academic writing. **Studies in Higher Education**, 2024b. DOI: 10.1080/03075079.2024.2323593.

NGUYEN, Andy; ILESANMI, Faith; DANG, Belle; VUORENMAA, Eija; JÄRVELÄ, Sanna. Hybrid intelligence in academic writing: examining self-regulated learning patterns in an AI-assisted writing task. **Frontiers in Artificial Intelligence and Applications**, 2024a. DOI: 10.3233/faia240198.

NOY, Shakked; ZHANG, Whitney. Experimental evidence on the productivity effects of generative artificial intelligence. **Science**, v. 381, p. 187, 2023. DOI: 10.1126/science.adh2586.

OERMANN, Eric K.; KONDZIOLKA, Douglas. On chatbots and generative artificial intelligence. **Neurosurgery**, v. 92, n. 4, p. 665-666, 2023. DOI: 10.1227/neu.0000000000002415.

OPENAI (2023a). GPT-4. United States of America. Available at: <https://openai.com/research/gpt-4>. Accessed on: November 20, 2023.

OPENAI (2023b). ChatGPT can now see, hear and speak. United States of America. Available at: <https://openai.com/blog/chatgpt-can-now-see-hear-and-speak>. Accessed on: November 20, 2023.

OPENAI (2023c). ChatGPT (GPT-4 model, Mar 23 version) [Large language model]. Retrieved June. 25, 2024, from: <https://chat.openai.com/chat>

OPENAI. Discovering and enacting the path to safe artificial general intelligence. United States of America. Available at: <https://openai.com>. Accessed on: March 4, 2020.

OPENAI. How OpenAI is approaching 2024 worldwide elections. United States of America. Available at: <https://openai.com/index/how-openai-is-approaching-2024-worldwide-elections/> Accessed on: June 14, 2024.

OXFORD. Word of the year 2016. **Oxford University Press**, 18 Nov. 2016. Available at: <https://global.oup.com/academic/content/word-of-the-year/?cc=br&lang=en&#:~:text=After%20much%20discussion%2C%20debate%2C%20and,t o%20emotion%20and%20personal%20belief.%22>. Accessed on: 14 Nov. 2023.

PALFREY, John; GASSER, Urs; SIMUN, Miriam; BARNES, Rosalie Fay. Youth, creativity, and copyright in the digital age. **International Journal of Learning and Media**, v. 1, n. 2, p. 79-97, 2009.

PAN, Jian. AI-driven English language learning program and academic writing integrity in the era of intelligent interface. **English Language Teaching and Linguistics Studies**, v. 6, n. 4, p. 120-120, 2024. DOI: 10.22158/eltls.v6n4p120.

PARAGUASSU, Lisandra; MARCELLO, Maria Carolina. **Brazil pro-democracy manifestos aim to curb Bolsonaro's election threats**. São Paulo, 11 Aug. 2022. Available at: <https://www.reuters.com/world/americas/brazil-pro-democracy-manifestos-aim-curb-bolsonaros-election-threats-2022-08-11/>. Accessed on: 13 Sept. 2023.

PARISER, Eli. **The filter bubble**: what the internet is hiding from you. London: Penguin UK, 2011.

PBS. Vencedora do Prêmio Nobel da Paz, Maria Ressa, sobre liberdade de imprensa. [S. l.]: [s. n.], 2021. Video (6m 19s). Available at: <https://www.pbs.org/video/peace-prize-1639175584/>. Accessed on: 10 June 2022.

PENG, Kuan-Po; MAY, A. Crossing the rubicon? the future impact of artificial intelligence on headache medicine. **Primer on Cerebrovascular Diseases**, v. 43, n. 4, p. 033310242311573-033310242311573, 2023. DOI: 10.1177/03331024231157379.

PETRAGLIA, Izabel. **Edgar Morin**: a educação e a complexidade do ser e do saber. 13. ed. [S. l.]: Ed. Vozes, 2020.

PETRAGLIA, Izabel; MORAES, Cândida Moraes. **Curso introdução ao pensamento complexo e implicações educacionais**. Video. [S. l.]: Centro de Estudos Edgar Morin, 2022a. Available at: <https://cepedgarmorin.com/cursoscepem/>. Accessed on: 2 Oct. 2023.

PETRAGLIA, Izabel; MORAES, Cândida. Epistemologia da complexidade e a pesquisa educacional. Video. [S. l.]: Centro de Estudos Edgar Morin, 2022b. Available at: <https://cepedgarmorin.com/cursoscepem/>. Accessed on: 10 Oct. 2023.

PINTO, Maria da Graça Lisboa Castro. Os meandros da escrita acadêmica: alguns recados aos estudantes universitários. **Linha d'água**, São Paulo, v. 31, n. 1, p. 9-27, Jan.-Apr. 2018. Available at: <https://doi.org/10.11606/issn.2236-4242.v31i1p9-27>.

PLATE, Daniel Robert; HUTSON, James. Augmented creativity: leveraging natural language processing for creative writing. **Art and Design Review**, v. 10, n. 03, p. 376-388, 31 Dec. 2022.

POLONSKY, Michael Jay. Should artificial intelligent agents be your co-author? arguments in favour, informed by ChatGPT. **Australasian Marketing Journal (AMJ)**, v. 31, p. 91-96, 2023. DOI: 10.1177/14413582231167882.

PRADO, Luiz; GARCIA, Carolina Borin. ChatGPT: entre o fascínio e o temor pela tecnologia. **Jornal da USP**, 17 Mar. 2023. Available at: <https://jornal.usp.br/cultura/chatgpt-entre-o-fascinio-e-o-temor-pela-tecnologia/>. Accessed on: 18 Mar. 2023.

RABBIANTY, Eva Nikmatul; AZIZAH, Siti; VIRDYNA, Nina Khayatul. AI in academic writing: assessing current usage and future implications. **Insania: Jurnal Pemikiran Alternatif Kependidikan**, v. 28, n. 1a, p. 14-35, 2023. DOI: 10.24090/insania.v28i1a.9278.

RADFORD, Alec; WU, Jeffrey; CHILD, Rewon; LUAN, David; AMODEI, Dario; SUTSKEVER, Ilya. Language models are unsupervised multitask learners. **OpenAI Blog**, v. 1, n. 8, p. 1-24, 2019.

RAHAYU, Rahayu; WEDA, Sukardi; MULIATI, Muliati; VEGA, Nofvia De. Artificial intelligence in writing instruction: a self-determination theory perspective. **XLinguae**, v. 17, n. 1, p. 234-244, 2023. DOI: 10.18355/xl.2024.17.01.16.

RAPPLER. About Maria A. Ressa. [S. l.]: [s. n.], [2021?]. Available at: <https://www.rappler.com/author/maria-a-ressa/>. Accessed on: 10 June. 2022.

RATCLIFFE, Rebecca. 'The Punisher': Rodrigo Duterte's violent reign as Philippines president to end. **The Guardian**, 28 June. 2022. Analysis. Available at: <https://www.theguardian.com/world/2022/jun/28/the-punisher-rodrigo-dutertes-violent-reign-as-philippines-president-to-end>. Accessed on: 01 July 2022.

RAVAGNOLI, Neiva Cristina da Silva Rego. **A anomia em um curso de formação contínua de professores de inglês da escola pública**: um olhar complexo. 2017. 142 f. Thesis (Doctorate in Applied Linguistics and Language Studies) – Postgraduate Program in Applied Linguistics and Language Studies, Pontifical Catholic University of São Paulo, São Paulo, 2017.

REISS-ANDERSEN, Beirit. Announcement of the 2021 Nobel Peace Prize, 2021. Video (15 h 51 min). Available at: https://www.youtube.com/live/7xRsj4oBixs?si=bCnqC6CzRM_EKyeM. Accessed on: 10 June 2022.

REZA, Mohi; LAUNDRY, N.; MUSABIROV, Ilya; DUSHNIKU, Peter; YU, Zhi Yuan Michael; MITTAL, Kashish; GROSSMAN, Tovi; LIUT, Michael; KUZMINYKH, Anastasia; WILLIAMS, Joseph Jay. ABScribe: rapid exploration of multiple writing variations in human-AI co-writing tasks using large language models. **arXiv.org**, v. abs/2310.00117, 28 Sept. 2023. Available at: <https://arxiv.org/abs/2310.00117>. Accessed on: 27 Jan. 2024.

ROE, J.; RENANDYA, Willy A.; JACOBS, George M. A review of AI-powered writing tools and their implications for academic integrity in the language classroom. **Journal of English and Applied Linguistics**, v. 2, n. 1, 2023. DOI: 10.59588/2961-3094.1035.

ROSCOE, Rod D.; SALEHI, Shima; NIXON, Nia; WORSLEY, Marcelo; PIECH, Chris; LUCKIN, Rose. Inclusion and equity as a paradigm shift for artificial intelligence in education. In: OUYANG, Fan; JIAO, Ping; MCLAREN, Bruce M.; ALAVI, Amir H. (ed.). **Artificial intelligence in STEM education: the paradigmatic shifts in research, education, and technology**. 1. ed. [S. l.]: CRC Press, 2022. p. 359-374. DOI: 10.1201/9781003181187-28.

RUSSEL, Stuart J., NORVIG, Peter. **Artificial Intelligence: a modern approach**. 4. ed. New Jersey: Prentice Hall, 2021. 1136 p.

RUSSELL-PINSON, Lisa; HARRIS, M. Lynne. Anguish and anxiety, stress and strain: attending to writers' stress in the dissertation process. **Journal of Second Language Writing**, v. 43, p. 63-71, 2019.

SANTAELLA, Lucia. A educação e o estado da arte das tecnologias digitais. In: SALES, M. S. (org.). **Tecnologias digitais, redes e educação: perspectivas contemporâneas**. Salvador, BA: Edufba, 2020. p. 149-163.

SANTAELLA, Lucia. **A Pós-verdade é verdadeira ou falsa?** Barueri, São Paulo: Estação das Letras e Cores, 2019.

SANTAELLA, Lucia. **Comunicação ubíqua: repercussões na cultura e na educação?** São Paulo: Paulus, 2013.

SANTOS, Bergston Luan; ARRUDA, Eucidio Pimenta. Dimensões da inteligência artificial no contexto da educação contemporânea. **Educação Unisinos**, v. 13, n. 4, p. 725-741, Oct.-Dec. 2019.

SCHUTTE, Nicola S.; MALOUFF, John M. Connections between curiosity, flow and creativity. Short Communication. **Personality and Individual Differences**, v. 152, p. 1-3, 2020.

SELIM, Abir Sabry Mohamed. The transformative impact of AI-powered tools on academic writing: perspectives of EFL university students. **International Journal of English Linguistics**, 2024. DOI: 10.5539/ijel.v14n1p14.

SHUMAILOV, I.; SHUMAYLOV, Z.; ZHAO, Y. *et al.* AI models collapse when trained on recursively generated data. **Nature**, v. 631, p. 755-759, 2024. DOI: 10.1038/s41586-024-07566-y.

SRBA, I.; MORO, R.; TOMLEIN, M.; PECHER, B.; SIMKO, J.; STEFANCOVA, E.; KOMPAN, M.; HRCKOVA, A.; PODROUZEK, J.; GAVORNIK, A.; BIELIKOVA, M. Auditing YouTube's recommendation algorithm for misinformation filter bubbles. **ACM Transactions on Recommender Systems**, v. 1, n. 1, p. 1-33, 2023. DOI: 10.1145/3568392.

STANZIONE. Provvedimento del 30 marzo 2023.

<https://www.garanteprivacy.it/web/guest/home/docweb/-/docweb-display/docweb/9870832>, Accessed on: 15 Nov. 2023.

STOKEL-WALKER, Chris. ChatGPT listed as author on research papers: many scientists disapprove. **Visual Education**, v. 613, n. 7945, p. 620-621, 2023. DOI: 10.1038/d41586-023-00107-z.

STORNAIUOLO, Amy; HIGGS, Jennifer; NICHOLS, T. Philip; LEBLANC, Robert Jean; DE ROOCK, Roberto Santiago. The platformization of writing instruction: considering educational equity in new learning ecologies. **Review of Research in Education**, v. 47, n. 1, p. 311-359, 2023. DOI: 10.3102/0091732X241227431.

SYSOYEV, Pavel V.; FILATOV, Evgeny M. Cognitive-matrix analysis as a tool for exploring cultural identity of a fiction author. **Vestnik Moskovskogo universiteta. Seriâ 19, Lingvistika i mežkul'turnaâ kommunikaciâ**, v. 27, n. 2, p. 38-54, 2024. DOI: 10.55959/msu-2074-1588-19-27-2-3.

TAMILSELVI, C.; EBENEZER, A. Shamila; DHANASAKKARAVARTHI, B.; DEVI, R.; DHANWANTH, Batini; MOHANAPRAKASH, T. A. A comprehensive study of AI-powered writing assistance tools and content spinning applications. In: INTERNATIONAL CONFERENCE ON ELECTRONICS, COMMUNICATION AND AEROSPACE TECHNOLOGY (ICECA), 7., 2023, Coimbatore. **Proceedings [...]**. IEEE Xplore Part Number: CFP23J88-ART; ISBN: 979-8-3503-4060-0. [S. l.]: [s. n.], 2023.

TAULLI, Tom. **Introdução à inteligência artificial: uma abordagem não técnica**. 1. ed. São Paulo: Novatec, 2020. 232 p.

THE NATIONAL COMMISSION ON WRITING. **Writing: a ticket to work. or a ticket out: a survey of business leaders**. [S. l.]: [s. n.], 2004. Available at: www.collegeboard.com/prod_downloads/writingcom/writing-ticket-to-work.pdf

THOMPSON, Paul. Achieving a voice of authority in PhD theses. In: HYLAND, K.; GUINDA, C. S. (ed.) **Stance and voice in written academic genres**. UK: Palgrave MacMillan, 2012. p. 119-133.

TU, Joseph; HADAN, Hilda; WANG, D.; SGANDURRA, Sabrina A.; MOGAVI, Reza Hadi; NACKE, Lennart E. Augmenting the author: exploring the potential of AI collaboration in academic writing. **arXiv:2404.16071**, 2024. DOI: 10.48550/arxiv.2404.16071. Available at: <https://arxiv.org/abs/2404.16071>. Accessed on: 21 June 2024.

VALLARINO, Diego. How worried should you be about AI disrupting elections? In: **The Economist**. 31 Aug. 2023. Available at: <https://www.economist.com/leaders/2023/08/31/how-artificial-intelligence-will-affect-the-elections-of-2024>. Accessed on: 15 Nov. 2023.

VIBERG, Olga; KIZILCEC, René F.; WISE, Alyssa Friend; JIVET, Ioana; DOWELL, Nia. Advancing equity and inclusion in educational practices with AI-powered educational decision support systems (AI-EDSS). **British Journal of Educational Technology**, 2024. DOI: 10.1111/bjet.13507.

WANG, Chaoran. Exploring students' generative AI-assisted writing processes: perceptions and experiences from native and nonnative English speakers. **Technology, Knowledge, and Learning**, 2024. DOI: 10.1007/s10758-024-09744-3.

WIKIPEDIA CONTRIBUTORS. English Wikipedia. Wikipedia, The Free Encyclopedia. 2021. Available at: https://en.wikipedia.org/w/index.php?title=English_Wikipedia&oldid=1185333965. Accessed on: 15 Sept. 2021.

XU, Yang'en. The double-edged sword of AI writing tools. **SocArXiv Papers**, 2024. DOI: 10.31235/osf.io/wnpd5.

YAN, Da. Impact of ChatGPT on learners in a L2 writing practicum: an exploratory investigation. **Education and Information Technologies**, v. 28, p. 13943-13967, 2023. Available at: <https://doi.org/10.1007/s10639-023-11742-4>. Accessed on: 4 Aug. 2024.

ZHI, Zhonghua Wei Chang Wai Ke Za. Role of artificial intelligence in the diagnosis and treatment of gastrointestinal diseases. **Chin J Gastrointest Surg**, v. 23, n. 1, p. 33-37, Jan. 2020. Available at: <https://doi.org/10.3760/cma.j.issn.1671-0274.2020.01.006>. Accessed on: 13 Nov. 2020.

ZARAMELA, Luciana. GPT-3: será que a IA escritora mais poderosa do mundo substitui um jornalista? In: **Canaltech**. 28 Jan. 2021. Available at: <https://canaltech.com.br/inteligencia-artificial/gpt-3-sera-que-a-ia-escritora-mais-poderosa-do-mundo-substitui-um-jornalista-178031/>. Accessed on: 15 Nov. 2021.

ZORLONI, Luca. OpenAI blocks ChatGPT in Italy. **Wired**, 31 Mar. 2023. Available at: <https://www.wired.it/article/openai-blocca-chatgpt-in-italia/>. Accessed on: 10 Apr. 2023.

APPENDIX I – Research credibility

Scientific events and activities	Where?	When?
Artificial Intelligence in English Language Writing. Oral communication at <i>I Seminário de Autoavaliação</i> (PPGED).	Brazil-UFS Synchronously/ Remotely	Apr. 28 2021
Pre-qualifying panel during the Research Seminar I course (PPGED), taught by Prof. Dr. Simone de Lucena Ferreira and Prof. Dr. Paulo Boa Sorte.	Brazil-UFS Synchronously/ Remotely	Sep. 30 2021
Presentation of the research project to TECLA research group members.	Brazil-UFS Synchronously/ Remotely	Nov. 8 2021
Generative AI writing assistants and their importance in education. Poster presentation at VCU Research Symposium – School of Education.	USA-Virginia Commonwealth University (VCU)	Mar. 10 2023
ChatGPT in Education: can we predict what's going to happen? Do we have to? Lecture for VCU Teacher education program – School of Education.	USA-VCU Synchronously/ Remotely	Apr. 11 2023
ChatGPT: potential, applications, and challenges in education and research. Live session for <i>Coordenação de Pesquisa - POSGRAP/UFS</i> conducted by Prof. Dr. Renata Ferreira Costa Bonifácio, research coordinator. @copes-ufs	Brazil-UFS Synchronously/ Remotely	Apr. 14 2023
Task-Based Language Learning and ChatGPT: how can we connect them? Lecture for Masters Program in Education at Facultad de Educación. Universidad El Bosque, Colombia.	Colombia Universidad El Bosque Synchronously/ Remotely	Apr. 21 2023
ChatGPT in Education: how does it exist beyond limits and challenges? Talk at <i>Roda de Mestres AI: limits and challenges for education teacher education program</i> at Centro Universitário Maurício de Nassau.	Brazil UNINASSAU Synchronously/ Remotely	June 17 2023
ChatGPT has come to stay. Oral communication at <i>VII Seminário Formação de Professores e Ensino de Língua Inglesa</i> (SEFELI).	Brazil-UFS In-person	Oct. 10 2023
ChatGPT and how it can be integrated into our education. A podcast hosted by Nabeeha Haque for the course: Cyborg Anthropology. AI Specialist Podcast	USA Georgetown University	Oct. 14 2023
Artificial Intelligence in Research and Postgraduate studies. Lecture co-presented with Prof. Dr. Paulo Boa Sorte at the <i>II Congresso Norte Nordeste de Pesquisa e Pós-graduação; V Encontro da Pós-graduação Stricto Sensu e o II Encontro da Pós-graduação Lato Sensu</i> at Universidade Estadual de Ciências da Saúde de Alagoas.	Brazil-UNCISAL Synchronously/ Remotely	Oct. 17 2023
Presentation of ongoing research to TECLA research members.	Brazil-UFS Synchronously/ Remotely	Nov. 13 2023
Generative AI: shaping the new era of writing and communication. Talk for Academy UFSC Program, Universidade Federal de Santa Catarina (UFSC). Novembro entre Elas	Brazil-UFSC Synchronously/ Remotely	Nov. 16 2023
ChatGPT in Academic Writing: 'to use or not to use' – is it still a question? Course presented at the <i>33º Encontro de Iniciação Científica</i> , Universidade Federal de Sergipe.	Brazil-UFS In-person	Nov. 28 2023

Qualifying exam presented to the Graduate Program in Education (PPGED), Universidade Federal de Sergipe.	Brazil-UFS Hybrid	Dec. 05 2023
ChatGPT: exploring applications, ethics, and implications in academic writing. Talk at the Department of Modern Languages, Universidade Federal de Sergipe.	Brazil-UFS In-person	Dec. 13 2023
Optimizing AI Text Generators for Multilingual Learners: the art of crafting effective prompts. Talk at 2024 Dr. Elizabeth Webb Professional Learning Series – Disciplinary Language & Literacy Communities of Practice, Georgia Teachers of English to Speakers of Other Languages (GATESOL).	USA GATESOL Synchronously/ Remotely	Jan. 11 2024
Leveraging AI Text Generators to Enhance Mentor Text Creation for Multilingual Learners. Talk co-presented with Prof. Dr. Luciana C. de Oliveira during SLW-CALL* Intersection Section, Reimagining multilingual writing through AI, at the TESOL* 2024 International Convention & Expo. *SLW (Second Language Writing), CALL (Computer Assisted Language Learning), TESOL (Teaching English to Speakers of Other Languages).	USA TESOL Tampa, FL In-person	Mar. 22 2024
Creating Custom Prompts with Generative AI to Face Academic Writing Challenges. Workshop presented for Faculty members at Center for Teaching Excellence and Faculty Development (CTEFD), Berry College.	USA Berry College In-person	Mar. 27 2024

Source: created by the author (2023).

APPENDIX II – Scientific publications

2021



BOA SORTE, Paulo; FARIAS, Mário André de Freitas.; SANTOS, Alessandra Elisabeth dos; SANTOS, Jefferson do Carmo Andrade; DIAS, Jamile Santos dos Santos Rodrigues. **Artificial intelligence in academic writing: what is in store with the GPT3 algorithm?** *EntreLinguas*, Araraquara, v. 7, n. 00, e021035, 2021. e-ISSN: 2447-3529.

2023



SANTOS, Alessandra Elisabeth dos; OLESOVA, Larisa; VICENTINI, Cristiane; OLIVEIRA, Luciana C.de **ChatGPT in ELT: Writing Affordances and Activities**. *TESOL Connections*, May 2023.

2023



SANTOS, Alessandra Elisabeth dos; SILVA, Laila Gardênia Viana; SIQUEIRA, Nadege Ramalho de. **ChatGPT e Implicações na Educação: o cenário da escrita acadêmica**. In: Cristiane Porto; Alexandre Chagas, Kaio Eduardo Oliveira. (Org.). *Educiber: Educação e divulgação científica em plataformas digitais*. 1ed.Aracaju: Edunit, 2023, v. 5, p. 204-222.



GUI, Jia; SANTOS, Alessandra Elisabeth dos. **Genre-based Pedagogy in English Language Arts Integrated with Generative Artificial Intelligence**. In L. C. de Oliveira (Ed.). *Applying a Functional Approach to Language Development in Teaching the Content Areas to Multilingual Learners in K-12 Classrooms*. Charlotte, NC: Information Age Publishing. Forthcoming.



SANTOS, Alessandra Elisabeth dos; BOA SORTE, Paulo; OLIVEIRA, Luciana C. de. **Generative Artificial Intelligence in Writing: ChatGPT and Critical Questioning for Multilingual Learners**. In C. Wang; Z. Tian (Ed.). *Rethinking Writing Education in the Age of Generative AI*. London: Routledge. Forthcoming.



SANTOS, Alessandra Elisabeth dos. **Optimizing AI-Text Generators for Multilingual Learners: the art of crafting effective prompts**. *GATESOL Journal*. Forthcoming.



OLIVEIRA, Luciana C. de.; SANTOS, Alessandra Elisabeth dos. **Using AI-Text Generated Mentor Texts for Genre Based Pedagogy in Second Language Writing**. Submitted.

