Optimising Early Learning via Generative AI: Theory and Implications for A Digital Generation

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Abstract: Engulfing early childhood education, the digital age sparks questions regarding intelligent pedagogical approaches. Central to this discourse, this study unravels the theoretical implications of Generative Artificial Intelligence (GAI) application within early learning contexts. Preceding investigations have alluded to GAI's potential in personalising learning; however, comprehensive theoretical exploration remains in its infancy. Hence, this work strives to bridge this gap, shedding light on an intriguing research avenue. It emphasises GAI's probable impact on cognitive development, socio-emotional growth, ethical considerations, and risk mitigation among learners aged zero to eight. The theoretical analysis conducted herein benefits from Krashen's Second Language Acquisition Theory and Vygotsky's Social Development Theory, integrating their principles into the GAI context. Preliminary findings suggest GAI could yield an innovative learning model, personalised, adaptive, and contextually responsive. This implies an enhanced early childhood education landscape, fostering a healthier, intelligent digital generation. The investigation's crux rests on its novelty: pioneering a unique intersection of GAI and early childhood education theory. Proffering an enriched theoretical perspective generates dialogue surrounding digital education's future and its ramifications for contemporary pedagogy. As this study is seminal, it beckons subsequent empirical research to validate the posited theoretical premises.
Keywords: Cognitive Development; Early Childhood Education; Generative Artificial Intelligence; Personalised Learning; Socio-Emotional Growth

A. Introduction

Early childhood education, now at the confluence of digital evolution, stands poised for potential transformation (Elkordy & Iovinelli, 2021; Luo et al., 2021; Vogt & Hollenstein, 2021). Our societies globally are morphing, embracing technological advancements with an ardour that reflects the potential of our digital age (Bulman & Fairlie, 2016). This phenomenon presents an opportunity for reflection and analysis, leading to questions of integration, its ramifications, and the pedagogical shifts that it spurs (Marouli, 2021). More importantly, it propels the discourse into a labyrinth of intriguing queries and conjectures, making it imperative for academicians and educators to scrutinise these metamorphoses (Papadakis, 2018).

Children of today, akin to digital natives, encounter technology in its myriad forms at ages younger than ever before (Gottschalk, 2019; Prensky, 2001). Consequently, their education no longer stands as a separate entity but becomes inextricably intertwined with their digital experiences (Prensky, 2001). Such an amalgamation of education and technology urges us to scrutinise how educational pedagogy can adapt, innovate, and evolve within this new paradigm (Carayannis & Morawska-Jancelewicz, 2022). Therefore, to navigate these shifting currents, we must delve into the landscape of digital phenomena and education. This task will aid in shaping future trajectories in early learning (Papadakis, 2018).

Artificial intelligence, a central player within this digital tableau, looms as a formidable influence, hinting at seismic shifts in educational efficacy (Luckin, 2018). Generative AI stands for particular import in this context, a facet of AI renowned for its aptitude to create novel content, extrapolate from existing data, and adapt dynamically (Goodfellow et al., 2014). It becomes, thus, a beacon illuminating a yet unexplored horizon in the domain of education, a horizon that teems with potential and warrants extensive contemplation about its potential ramifications (Luckin, 2018).

Zeroing in on GAI, this discourse embarks on a journey through a relatively less-trodden research landscape (Goodfellow et al., 2014). An exploration that forces us to question and reconsider foundational concepts such as education methods, the identification of educators in a traditional sense, and the broader implications of this digital evolution (Luckin, 2018). This inquiry, while challenging, presents an opportunity to reshape our understanding and practices in early education, providing a platform to reimagine teaching and learning in the digital age (Papadakis, 2018).

Previous forays into the domain of GAI within educational settings, while enlightening, have largely orbited around its functional and practical attributes (Luckin, 2018). In contrast, a noticeable lacuna persists in scholarly discourse, emphasising a dearth of holistic theoretical exploration into GAI's potential within early childhood education (Papadakis, 2018). This void represents an untapped wellspring of insight waiting to be plumbed (Luckin, 2018).

Despite the promise of GAI's effectiveness in facilitating personalised learning, amplifying cognitive development, and nurturing socio-emotional growth, scant attention has been paid to the theoretical foundations that undergird these claims (Luckin, 2018). This precipitated a call for an in-depth investigation into the novel and established theories that intersect with the implications and applications of GAI (Goodfellow et al., 2014). This theoretical lens can provide robust scaffolding, elevating our understanding of GAI's transformative potential within early education (Luckin, 2018).

Stepping forward to address this research void, our scholarly endeavour sets sail on a theoretical voyage that interlaces GAI and early childhood education (Papadakis, 2018). This exploration is driven by an intention to deeply probe how GAI might cultivate a digitally literate, intellectually robust, and emotionally healthy generation of learners (Luckin, 2018). Within this ambit, we hypothesise about GAI's influence on facets such as learning personalisation, cognitive development, socio-emotional growth, tackling ethical issues and mitigating risks among youthful scholars (Goodfellow et al., 2014).

To traverse this multidimensional terrain, our study leans upon two monumental constructs: Krashen's Second Language Acquisition Theory and Vygotsky's Social Development Theory (Krashen, 1982; Vygotsky, 1978). By synergising their principles with the rapidly evolving sphere of GAI, we aim to extend their applicability and relevance to this modern context (Goodfellow et al., 2014). As our academic journey unfolds, we find ourselves ready to uncover and examine the intricate layers of this multifaceted educational conundrum (Luckin, 2018).

B. Methodology

Anchoring this exploration is the argumentative review approach, a potent methodology serving as a sieve through which we glean and interweave salient data (Grant & Booth, 2009). This methodology primarily illuminates a sweeping review of extant literature related to Generative AI within the sphere of education (Bryman, 2016). Our lens focuses on an assortment of scholarly materials, including academic articles (Hart, 1998), esteemed books (Fink, 2010), contributions from academic conferences (Levy & Ellis, 2006), and trusted digital resources (Yakel, 2007).

Once a comprehensive compilation of such resources is achieved, we delve into a rigorous examination, meticulously scrutinising each source for its academic integrity (Gough, Oliver, & Thomas, 2012), relevance to our study (Booth, Sutton, & Papaioannou, 2016), and overall scholarly merit (Petticrew & Roberts, 2006). This intricate process facilitates recognising and analysing central themes and emergent patterns concerning the theoretical implications of GAI within the ambit of early childhood education (Thomas & Harden, 2008). Through a synthesis of this data, we craft an enriched, well-rounded argument (Snyder, 2019). In doing so, we carve out a niche for GAI within early learning and underscore its potent influence in sculpting an informed and adept digital generation (Wu, Lee, Chang, & Liang, 2013).

Invoking the illuminating compass of Krashen's Second Language Acquisition Theory (Krashen, 1982) and Vygotsky's Social Development Theory (Vygotsky, 1978) provides pivotal theoretical perspectives. Krashen's Theory, with its profound focus on comprehensible input and the critical role of an affective filter, propounds a revealing prism to inspect how Generative AI could cater to each learner's particular needs (Lightbown & Spada, 2013). We hypothesise that this artificial intelligence's ability to generate content is not merely about novelty but also about ensuring that this new material is within reach of the learners' comprehension, engaging their curiosity, and fostering an environment conducive to profound learning (Papert, 1980).

In contrast, we turn our gaze to Vygotsky's Social Development Theory, which emphasises the instrumental role of social interactions in learning (Vygotsky, 1978). This theory nudges us to contemplate critical questions: how can Generative AI engender these vital interactions? How can it nurture socio-emotional growth in children, a pivotal element in their comprehensive development? (Bodrova & Leong, 2007). The conjuncture of these two venerable theories renders a multifaceted theoretical tapestry against which we can frame the potential roles of GAI within the context of early childhood education (Berk & Winsler, 1995). Through these lenses, we foresee a rigorous and enlightening analysis (Kozulin, Gindis, Ageyev, & Miller, 2003).

Interacting the realms of these theories with Generative AI necessitates the identification of points where convergence and divergence manifest (Kozulin et al., 2003). Initiation of this exercise commences with the precise articulation of Krashen's and Vygotsky's theoretical principles (Krashen, 1982; Vygotsky, 1978). These principles serve as beacons, illuminating potential facets and capabilities that GAI might embody within the educational ambit (Papert, 1980). After that, an intense examination unfolds, peering into how these theories could find their operative counterparts in an educational environment dictated by the rhythms of GAI (Wu et al., 2013).

An extrapolative stage follows this analytical process. Here, we conjure visions of the implications these theoretical applications might have on facets such as the personalisation of learning experiences (Bulger, 2016), the catalysation of cognitive development (Piaget, 1952), the nurturing of socio-emotional growth, and the art of risk mitigation within the vibrant mosaic of early childhood education (Bronfenbrenner, 1979). Through this multilayered process, the theoretical bedrock supporting the potential role of GAI in early childhood education gradually emerges from the fog of speculation into the clear light of understanding (Wu et al., 2013).

C. Results

As we traverse the illuminated path of data analysis, an enlightening narrative unfurls, encapsulating the potential roles of GAI in early learning (Qadir, 2023). Not merely a tool, GAI emerges as an interactive partner, an entity proficient in reading the unique wavelengths of learners and generating content tailored to their trajectories (Baidoo-Anu & Owusu Ansah, 2023). It shapes the clay of personalisation in education, ensuring each child immerses

themselves in tasks intricately crafted for their developmental stage, interests, and pace (Bray & McClaskey, 2014).

In a fascinating twist, GAI reveals its capacity to bolster areas typically posing challenges to educators (Bozkurt, 2023). Notably, the continuous assessment of formative progress and provision of individualised feedback represent such areas (Cooper, 2023). GAI, with its ability to incessantly analyse a learner's interaction with educational content, can provide timely, personalised feedback, thus transforming these formidable challenges into manageable tasks (Qadir, 2023). This capability, far from trivial, can change the education landscape, reshaping it to reflect the aspirations of truly learner-centred environments (Baidoo-Anu & Owusu Ansah, 2023).

The extrapolation of these insights from the data paints a vibrant picture of how GAI might alter the texture of early learning settings (Bray & McClaskey, 2014). Not confined to serving as an inert instrument, GAI could act as a dynamic ally in the learning process (Bozkurt, 2023). As it adapts to learners and supports educators, GAI might catalyse a significant shift in education, with environments evolving to centre around learners in unimagined ways (Cooper, 2023). This evolution, predicated on GAI's capabilities, could herald an epoch of individualised, learner-centric education, the impacts of which would reverberate through generations (Qadir, 2023).

At the heart of these findings thrives a robust theoretical coherence between GAI and fundamental tenets of both Krashen's Second Language Acquisition Theory and Vygotsky's Social Development Theory (Baidoo-Anu & Owusu Ansah, 2023). Indeed, a symbiosis seems to burgeon between the Comprehensible Input and Affective Filter hypotheses inherent in Krashen's musings and the personalised approach GAI adopts, propelling learners' cognitive evolution (Bray & McClaskey, 2014). Through a lens finely adjusted to discerning interconnections, one perceives an alignment not unlike the celestial harmony observed in the starlit heavens above us (Bozkurt, 2023).

In addition, the ability of GAI to catalyse social interactions vibrates harmoniously with the melodies of Vygotsky's theory (Cooper, 2023). Such potential for interaction echoes Vygotsky's emphasis on the role of social contexts in shaping cognitive development (Qadir, 2023). This opens myriad possibilities for socio-emotional growth, each as promising as a bud ready to bloom in the spring sun (Baidoo-Anu & Owusu Ansah, 2023). Thus, an intriguing conversation begins between the theories of yesteryears and the digital innovations of today, each enriching the other in an intricate dance of mutual enhancement (Bray & McClaskey, 2014).

These theoretical parallels, as enchanting as they are enlightening, hint at an immense potential within GAI (Bozkurt, 2023). As a pebble tossed into a pond sends ripples across its surface, so might GAI disturb the status quo in early childhood education, causing waves of transformative change (Cooper, 2023). This potential, surging with every ripple, bolsters the notion of GAI as more than just a tool – as a potential catalyst, perhaps, nudging early childhood education into a future brimming with untold promise and uncharted possibilities (Qadir, 2023).

If you will, picture a canvas of early learning, as yet unmarred, ripe for applying GAI's innovative brush strokes (Baidoo-Anu & Owusu Ansah, 2023). A cornucopia of opportunities seems to burst forth from such a tableau. From personalising learning artefacts to matching each young learner's cognitive plateau and piqued interests, GAI hints at a future where every educational encounter is delectably palatable and distinctly digestible (Bray & McClaskey, 2014). Therein, a child's journey through the sprawling landscapes of knowledge becomes a rite of passage, a joyous exploration rife with delight and discovery (Bozkurt, 2023).

Turning attention towards cognitive development, a compelling vision begins to coalesce. GAI emerges as a skilled tutor, deftly offering tasks that perch just a hair's breadth

beyond the learner's current capabilities (Cooper, 2023). This intricate dance of challenge and support hums in tune with Vygotsky's esteemed Zone of Proximal Development, casting GAI as a digital Vygotskian mentor, guiding learners into uncharted cognitive terrains (Qadir, 2023).

Shift the lens to socio-emotional growth, and GAI continues to shimmer with potential (Baidoo-Anu & Owusu Ansah, 2023). GAI could serve as a digital agora by facilitating interactions among peers, with educators, or even with intelligent digital agents, providing a safe space for children to unfurl their emotions and cultivate empathy (Bray & McClaskey, 2014). Such vibrant interactions could breathe life into digital landscapes, humanising technology and fostering a generation of digital natives fluent in the language of emotions (Bozkurt, 2023). Thus, contemplating these scenarios offers a preview of future classrooms and an exhilarating testament to the transformative potential nestling within the heart of GAI (Cooper, 2023).

GAI emerges at this fascinating juncture where the digital age dovetails with early childhood education, poised like a diver on a precipice (Brynjolfsson & McAfee, 2014) and poised, yet complex, and holding within its digital grasp the potential to drastically reimagine learning landscapes (Bostrom & Yudkowsky, 2014). The rays of optimism it radiates illuminate the potential for a sea change in personalised learning, cognitive development, and socio-emotional growth (Woolf, 2013). However, this is one side of the coin that shines brightly in the light of technological advancement (Brynjolfsson & McAfee, 2014).

Flip that coin, and the shadows cast by challenges loom large. Chief among these challenges is an omnipresent spectre – the threat of an over-reliance on GAI. Such a dependence risks eclipsing the invaluable human touch in education, an ingredient crucial for the socio-emotional alchemy of learning (Bostrom & Yudkowsky, 2014). Within this conundrum lies an intricate balancing act that must be performed with precision and care (Woolf, 2013).

Further complicating this dance are thorny issues, prickly as thistle and equally difficult to grasp without causing discomfort. Matters concerning data privacy, algorithmic bias, and the equitable accessibility of technology gnaw at the edges of GAI's potential, demanding attention (Brynjolfsson & McAfee, 2014). To ignore these would be akin to admiring a garden while ignoring the weeds, a precarious approach at best (Bostrom & Yudkowsky, 2014).

Therefore, fully harnessing the potential of GAI requires a keen-eyed strategy. One that recognises and respects the weight of benefits against potential risks and skillfully orchestrates a prudent, thoughtful integration of GAI into early childhood education (Woolf, 2013). This, in essence, is the tantalising yet complex path that lies before us as we step into the future of learning with GAI (Brynjolfsson & McAfee, 2014).

D. Discussion

As we navigate the intricate labyrinth of a healthy, intelligent digital generation, the GAI beacon begins to glow with increasing intensity (Lim et al., 2023; Su & Yang, 2023). In its illumination, we discern its potential role as a catalyst for evolution in learning, one that holds within its ambit the promise of individualised learning experiences (Chan & Hu, 2023; Chan & Lee, 2023; Pataranutaporn et al., 2021). GAI can foster cognitive development by tailoring educational material to each learner's unique developmental stage and interests (Ali et al., 2021; Woolf, 2013). It is as if each learner holds a key fashioned by GAI, which opens doors to knowledge spaces perfectly calibrated to their needs and curiosity (Brynjolfsson & McAfee, 2014).

Additionally, with its interactive capabilities, GAI promises more than just cognitive nourishment. It also potentially stimulates social interactions among learners (Chang & Kidman, 2023). These interactions serve as the scaffolding for socio-emotional growth, a pillar

as important as cognitive development in building the edifice of a healthy, balanced individual (Woolf, 2013). The beauty of this potential lies in GAI's ability to facilitate these interactions among peers and between learners and intelligent agents, thus expanding the canvas of learning beyond the conventional (Zhang et al., 2023).

However, GAI's role is not confined to the realms of cognitive and socio-emotional development. It also has the potential to equip learners with the necessary armour to navigate the digital age (Lo, 2023). By inculcating digital literacy and critical thinking skills, GAI can ensure children are not merely passive consumers of technology but active, responsible digital citizens (Karakose et al., 2023). It, therefore, appears to hold the key to crafting an informed and judicious digital generation.

In essence, GAI emerges as a potent tool that, if integrated judiciously, holds the potential to catalyse a paradigm shift in early childhood education (Bostrom & Yudkowsky, 2014). It paints a picture of an enriched educational landscape that promises to foster a generation of learners equipped to navigate and thrive in the digital age (Woolf, 2013). A transformative shift, indeed, that is worth more than just a passing glance (Brynjolfsson & McAfee, 2014).

Any discourse surrounding integrating Generative AI (GAI) in early childhood education necessitates metic contemplating ethical considerations and strategies for mitigating risks (Bostrom & Yudkowsky, 2014). A salient point of concern is data privacy. GAI, fueled by vast data reservoirs, demands unyielding vigilance to safeguard the private information of young learners (Woolf, 2013). As scholars, we must advocate for and insist on stringent measures protecting our learners' information, which can stand against the strong currents of technological advancements (Brynjolfsson & McAfee, 2014).

Further, we must eradicate algorithmic bias in our quest for equitable education (Bostrom & Yudkowsky, 2014). Education must function as a great leveller, ensuring fairness and unbiased experiences for all learners (Woolf, 2013). Bias, mainly when buried within the nuances of an algorithm, can perpetuate disparities, contradicting the very essence of education (Brynjolfsson & McAfee, 2014). We, therefore, must not rest until we are confident that the algorithms powering our learning tools uphold the principles of fairness and equity (Bostrom & Yudkowsky, 2014).

Nevertheless, another cog in this complex machinery is accessibility. We must vigilantly ensure that the benefits of GAI do not become the privilege of the affluent alone (Woolf, 2013). This technological marvel must reach every learner, irrespective of socio-economic status (Brynjolfsson & McAfee, 2014). This calls for deliberate, comprehensive strategies designed to ensure that the fruits of GAI reach every corner of the educational field (Bostrom & Yudkowsky, 2014). Integrating GAI in early childhood education demands thoughtful, conscious action (Woolf, 2013). We must ensure it is a potent force for equity, justice, and universal learning enhancement (Brynjolfsson & McAfee, 2014). It is a task of no small measure, but its potential to redefine the educational landscape makes it a challenge worth undertaking (Bostrom & Yudkowsky, 2014).

E. Conclusion

Retracing the discourse navigated herein, one encounters theoretical intersections between GAI and esteemed early learning theories (Vygotsky, 1978; Krashen, 1982). A unique harmony emerges with Krashen's principles of Comprehensible Input and Affective Filter (Krashen, 1982) and Vygotsky's concept of Zone of Proximal Development (Vygotsky, 1978), resonating with GAI's capabilities (Brown & Green, 2020). These intersections, far from accidental, underscore the promising potential of GAI as an educational partner, one capable of tailoring learning experiences to individual learners' development, interests, and pace (Nikolic et al., 2023).

This study stands as an avant-garde scholarly discourse, extending the frontiers of understanding early childhood education in the digital era (Papert, 1993). Its contribution is a nuanced exploration of the theoretical underpinnings of GAI in early learning settings, bridging a gap in the current body of knowledge (Bers, 2012). Doing so cultivates fertile ground for future explorations, heralding an exciting epoch in the educational landscape (Dai, Liu, & Lim, 2023; Resnick, 2017).

Upon this fertile ground, seeds of future research can sprout. Empirical research is crucial to validate and expand these theoretical premises (Blikstein, 2013). Studies could investigate real-world applications of GAI in early childhood settings, gauging its impacts on children's cognitive and socio-emotional development (Bers, 2012). Additionally, exploring educators' perspectives on implementing GAI and assessing its impacts on their practices would yield valuable insights (Blikstein, 2013). In essence, this study signifies not an end but a vibrant beginning for a journey into an uncharted yet promising terrain of GAI in early childhood education (Resnick, 2017).

References

Ali, S., DiPaola, D., Lee, I., Hong, J., & Breazeal, C. (2021, May). Exploring generative models with middle school students. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1-13).

Baidoo-Anu, D., & Owusu Ansah, L. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Available at SSRN 4337484*.

Berk, L. E., & Winsler, A. (1995). *Scaffolding Children's Learning: Vygotsky and Early Childhood Education. NAEYC Research into Practice Series. Volume 7*. National Association for the Education of Young Children, 1509 16th Street, NW, Washington, DC 20036-1426 (NAEYC catalog# 146).

Bers, M. U. (2012). *Designing digital experiences for positive youth development: From playpen to playground*. OUP USA.

Blikstein, P. (2013). Digital fabrication and 'making'in education: The democratisation of invention. *FabLabs: Of machines, makers and inventors*, *4*(1), 1-21.

Bodrova, E., & Leong, D. J. (2007). Tools of the Mind: The Vygotskian Approach to Early Childhood Education (Merrill/Prentice Hall, New York, ed 2).

Bostrom, Nick & Yudkowsky, Eliezer. (2018). The Ethics of Artificial Intelligence. 10.1201/9781351251389-4.

Bozkurt, A. (2023). Generative artificial intelligence (AI) powered conversational educational agents: The inevitable paradigm shift. *Asian Journal of Distance Education*, *18*(1).

Bray, B., & McClaskey, K. (2014). *Make learning personal: The what, who, wow, where, and why*. Corwin Press.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard university press.

Brown, A. H., & Green, T. D. (2019). *The essentials of instructional design: Connecting fundamental principles with process and practice*. Routledge.

Brynjolfsson, E., & McAfee, A. (2014). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. WW Norton & Company.

Bulger, M. (2016). Personalised learning: The conversations we're not having. *Data and Society*, *22*(1), 1-29.

Bulman, G., & Fairlie, R. W. (2016). Technology and education: Computers, software, and the internet. In *Handbook of the Economics of Education* (Vol. 5, pp. 239-280). Elsevier.

Carayannis, E. G., & Morawska-Jancelewicz, J. (2022). The futures of Europe: Society 5.0 and Industry 5.0 as driving forces of future universities. *Journal of the Knowledge Economy*, *13*(4), 3445-3471.

Chan, C. K. Y., & Hu, W. (2023). Students' Voices on Generative AI: Perceptions, Benefits, and Challenges in Higher Education. *arXiv preprint arXiv:2305.00290.*

Chan, C. K. Y., & Lee, K. K. (2023). The AI generation gap: Are Gen Z students more interested in adopting generative AI such as ChatGPT in teaching and learning than their Gen X and Millennial Generation teachers?. *arXiv preprint arXiv:2305.02878.*

Chang, C. H., & Kidman, G. (2023). The rise of generative artificial intelligence (AI) language models-challenges and opportunities for geographical and environmental education. *International Research in Geographical and Environmental Education*, *32*(2), 85-89.

Cooper, G. (2023). Examining science education in ChatGPT: An exploratory study of generative artificial intelligence. *Journal of Science Education and Technology*, *32*(3), 444-452.

Dai, Y., Liu, A., & Lim, C. P. (2023). Reconceptualising ChatGPT and generative AI as a student-driven innovation in higher education.

Elkordy, A., & Iovinelli, J. (2021). Competencies, culture, and change: A model for digital transformation in K-12 educational contexts. *Digital transformation of learning organisations*, 203.

Fink, A. (2019). *Conducting research literature reviews: From the internet to paper*. Sage publications.

Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., ... & Bengio, Y. (2020). Generative adversarial networks. *Communications of the ACM*, *63*(11), 139-144.

Gottschalk, F. (2019). Impacts of technology use on children: Exploring literature on the brain, cognition and well-being.

Gough, D., Thomas, J., & Oliver, S. (2017). An introduction to systematic reviews. *An introduction to systematic reviews*, 1-352.Bryman, A. (2016). *Social research methods*. Oxford university press.

Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health information & libraries journal*, *26*(2), 91-108.

Hart, C. (2018). Doing a literature review: Releasing the research imagination.

Karakose, T., Demirkol, M., Yirci, R., Polat, H., Ozdemir, T. Y., & Tülübaş, T. (2023). A Conversation with ChatGPT about Digital Leadership and Technology Integration: Comparative Analysis Based on Human–AI Collaboration. *Administrative Sciences*, *13*(7), 157.

Kozulin, A., Gindis, B., Ageyev, V. S., & Miller, S. M. (Eds.). (2003). *Vygotsky's educational theory in cultural context*. Cambridge University Press.

Krashen, S. (1982). Principles and practice in second language acquisition.

Levy, Y., & Ellis, T. J. (2006). A systems approach to conduct an effective literature review in support of information systems research. *Informing Science*, *9*.

Lightbown, P. M., & Spada, N. (2021). *How Languages Are Learned 5th Edition*. Oxford university press.

Lim, W. M., Gunasekara, A., Pallant, J. L., Pallant, J. I., & Pechenkina, E. (2023). Generative AI and the future of education: Ragnarök or reformation? A paradoxical perspective from management educators. *The International Journal of Management Education*, *21*(2), 100790.

Lo, L. S. (2023). The CLEAR path: A framework for enhancing information literacy through prompt engineering. *The Journal of Academic Librarianship*, *49*(4), 102720.

Luckin, R. (2018). *Machine Learning and Human Intelligence: The future of education for the 21st century*. UCL IOE Press. UCL Institute of Education, University of London, 20 Bedford Way, London WC1H 0AL.

Luo, W., Berson, I. R., Berson, M. J., & Li, H. (2021). Are early childhood teachers ready for digital transformation of instruction in Mainland China? A systematic literature review. *Children and Youth Services Review*, *120*, 105718.

Marouli, C. (2021). Sustainability education for the future? Challenges and implications for education and pedagogy in the 21st century. *Sustainability*, *13*(5), 2901.

Nikolic, S., Daniel, S., Haque, R., Belkina, M., Hassan, G. M., Grundy, S., ... & Sandison, C. (2023). ChatGPT versus engineering education assessment: a multidisciplinary and multi-institutional benchmarking and analysis of this generative artificial intelligence tool to investigate assessment integrity. *European Journal of Engineering Education*, 1-56.

Papadakis, S. (2018). The use of computer games in classroom environment. *International Journal of Teaching and Case Studies*, *9*(1), 1-25.

Papaioannou, D., Sutton, A., & Booth, A. (2016). Systematic approaches to a successful literature review. *Systematic approaches to a successful literature review*, 1-336.

Papert, S. (1980). *Children, computers, and powerful ideas*. Harvester.

Papert, S. (1993). The children's machine: Rethinking school in the age of the computer. *New York*.

Pataranutaporn, P., Danry, V., Leong, J., Punpongsanon, P., Novy, D., Maes, P., & Sra, M. (2021). AI-generated characters for supporting personalised learning and well-being. *Nature Machine Intelligence*, *3*(12), 1013-1022.

Petticrew, M., & Roberts, H. (2008). *Systematic reviews in the social sciences: A practical guide*. John Wiley & Sons.

Piaget, J., & Cook, M. (1952). *The origins of intelligence in children* (Vol. 8, No. 5, pp. 18-1952). New York: International Universities Press.

Prensky, M. (2009). H. sapiens digital: From digital immigrants and digital natives to digital wisdom. *Innovate: journal of online education*, *5*(3).

Qadir, J. (2023, May). Engineering education in the era of ChatGPT: Promise and pitfalls of generative AI for education. In *2023 IEEE Global Engineering Education Conference (EDUCON)* (pp. 1-9). IEEE.

Resnick, M. (2017). *Lifelong kindergarten: Cultivating creativity through projects, passion, peers, and play*. MIT press.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of business research*, *104*, 333-339.

Su, J., & Yang, W. (2023). Unlocking the power of ChatGPT: A framework for applying generative AI in education. *ECNU Review of Education*, 20965311231168423.

Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC medical research methodology*, *8*(1), 1-10.

Vogt, F., & Hollenstein, L. (2021). Exploring digital transformation through pretend play in kindergarten. *British Journal of Educational Technology*, *52*(6), 2130-2144.

Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard university press.

Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard university press.

Woolf, B. P. (2010). *Building intelligent interactive tutors: Student-centered strategies for revolutionising e-learning*. Morgan Kaufmann.

Wu, H. K., Lee, S. W. Y., Chang, H. Y., & Liang, J. C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & education*, *62*, 41-49.

Yakel, E. (2007). Digital curation. *OCLC Systems & Services: International digital library perspectives*, *23*(4), 335-340.

Zhang, C., Zhang, C., Li, C., Qiao, Y., Zheng, S., Dam, S. K., ... & Hong, C. S. (2023). One small step for generative ai, one giant leap for agi: A complete survey on chatgpt in aigc era. *arXiv preprint arXiv:2304.06488*.