JUTLP
Journal of University Teaching & Learning Practice

Digital competencies in student learning with generative artificial intelligence: Policy implications from world-class universities

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Abstract

In the context of digital transformation and given the recent emergence of Generative Artificial Intelligence (GAI), it is vital to identify the skills needed for using this technology in teaching and learning. This study investigates the digital competence required for utilizing GAI in learning and the corresponding policy implications. Adopting the DigComp framework, a qualitative content analysis of regulatory documents from 88 globally distributed world-class universities was conducted to uncover students' digital competence levels in using GAI and identify influential factors. Findings indicate that these higher education institutions (HEIs) place a strong emphasis on digital literacy, safety, and critical thinking when regulating students' competence in the use of GAI technologies. However, it is also evident that communication and collaboration competencies are often overlooked in the implementation of GAI technologies within educational settings. Moreover, as the world-class universities primarily focus on enhancing students' output capability and assessing their learning outcomes, challenges arise in terms of content creation and problem-solving competence when implementing GAI technologies. Consequently, key policy implications and recommendations are provided for educational policymakers and practitioners to address these gaps and enhance the effective integration of GAI in learning environments across various global contexts.

Editors

Section: Educational Leadership and Management
Senior Editor: Dr Averil Grieve
Associate Editor: Dr Michael Agyemang Adarkwah

Publication

Submission: 16 Dec 2024
Revised: 15 March 2025
Accepted: 5 May 2025
Publication: 26 May 2025

Practitioner Notes

1. When developing digital competencies for teachers and students, practitioners are advised to integrate technical skills, communication, pedagogical strategies, and infrastructure support for teachers and students.
2. Targeted policies to address digital inequity should consider subsidized connectivity, infrastructure development, and digital literacy programs for underserved populations.
3. The education industry should adopt data governance protocols to ensure transparency, accountability, and fairness in AI decision-making processes.
4. Teachers should prioritize critical reflection and ethical evaluation of AI tools in education to promote responsible and inclusive learning.
5. When promoting AI-enabled learning, practitioners should consider personalized education to ensure measurable improvements in the quality and inclusivity of student learning experiences.

Keywords

Digital competence, Artificial intelligence, Higher education, ChatGPT, Adaptive teaching

Citation:
Zhang, Y. & Tian, Z. (2025). Digital competencies in student learning with generative artificial intelligence: Policy implications from world-class universities. *Journal of University Teaching and Learning Practice*, 22(2). https://doi.org/10.53761/av7c8830

Introduction

The world has undergone a significant transformation due to the widespread adoption of technologization and greater awareness of the importance of digitalization (Castro et al., 2021). Generative artificial intelligence (GenAI) has undergone pivotal advancements, prompting studies to project significant transformations in the employment market and broader societal landscape (Pacis & VanWynsberghe, 2020). Consequently, this evolution underscores the imperative for university-level education to prioritize the cultivation of digital competencies among future professionals, ensuring their preparedness for emerging occupational demands and socio-technical shifts.

Digital competencies — the ability to comprehend and utilize technologies in everyday life, as well as appreciate their broader implications in the digital world — thus assume a critical role in the delivery of high-quality education (Spante et al., 2018). Scholars and global organizations have debated the necessity of future digital skills in an increasingly technology-driven world. For instance, the European Commission (2019) identified eight key competencies for lifelong learning in the digital era, emphasizing adaptability and technological literacy. Ehlers (2020) further argued that future competencies should prioritize action-oriented skills to address rapid social and economic shifts spurred by digital innovation. Similarly, the McKinsey and Company (2023) highlighted the critical role of cross-industry skills and domain-specific technological competencies in navigating the evolving labour market.

However, the conceptualization of digital competencies in the era of GenAI remains fragmented. While the importance of such skills is widely acknowledged, their application varies significantly across professions. A stream of social science research has emphasized the cognitive and sociological dimensions of digital competencies in the GenAI era (Røkenes & Krumsvik, 2016; Vishnu et al., 2022). Meanwhile, other studies originating from the sciences have sought to highlight ongoing efforts to develop and refine engineering techniques when addressing the challenges of digital competency in the face of GenAI (OpenAI & Ekin, 2023).

Recent studies have attempted to delineate digital competencies into more specific categories, but have been impeded by an insufficient clarification of the underlying literacy components (Ehlers et al., 2023). While digital technologies are developing at a never-before-seen pace, concerns about the slow shifts or transformations in pedagogy and students' competencies to adjust to the digitally aware age are rising (Okoye et al., 2023; Yang, 2023). Although research increasingly intends to incorporate an institutional perspective to examine contemporary AI policies in various higher education institutions (HEIs) (Chan, 2023; Da Mota, 2024), the outcomes and suggested frameworks emphasise stakeholders and institutional management within educational contexts rather than the digital competencies of individuals. As Olszewski and Crompton (2020) contend, it is imperative to develop a cohesive framework for digital competencies that bridges disciplinary divides and addresses the unprecedented socio-technical disruptions of the GenAI age.

Literature

In most educational settings, students are increasingly required to interact with digital technology as an integral component of their daily classroom activities and academic assignments. This rising pedagogical approach is predicated on the necessity of preparing learners for the evolving

demands of their future professional careers (Tiede et al., 2022). Existing research has also reached a broad consensus regarding the positive role of digital technologies and platforms in facilitating student participation, motivation, and academic performance (Purwanto et al., 2023).

Meanwhile, the advent of emergent digital technologies possesses the potential to radically transform the manner in which educational content is consumed, thereby presenting both advantageous opportunities as well as formidable challenges for educational institutions charged with equipping students to meet the exigent demands of the future labour market. Both scholars and practitioners have become more and more conscious of the assessment and evaluation of digital competency as a result of the growth of digital and technology learning and management platforms like Moodle, Canvas, Massive Open Online Courses, and flipped classrooms (Althubyani, 2024). Deftly navigating this rapidly evolving landscape necessitates a nuanced comprehension of the multifaceted character of digital competencies and the judicious cultivation thereof within educational environments.

While digital competency is a broad concept with relevance to various fields, no unified definition presently exists (Althubyani, 2024). In most definitions that have been put forward so far, emphasis is placed on digital skills and knowledge, and an ample body of empirical evidence indicates that digital competencies extend beyond mere technical skills. According to the European Commission, digital competencies refer to “the ability to relate to and use digital tools and media in a safe, critical and creative way. It is about knowledge, skills and attitudes. It is about being able to perform practical tasks, communicate, obtain or process information. Digital judgement, such as privacy, source criticism and information security, is also an important part of digital competencies” (European Commission, 2006, p.3).

With the advancement of GenAI technology, it has become feasible to train machines to automatically generate content in response to user questions or inputs. Notably, the utilization of Large Language Models in GenAI software — such as ChatGPT, Google Bard, and Microsoft Copilot — has become widespread, as these tools are capable of generating various forms of content including text, code, and images, and even simulating student assessment methodologies to reinforce assessment tasks (Hong et al., 2022; Lee et al., 2023). Consequently, scholarly discourse has posited that the constituent elements comprising digital competencies encompass not merely capacities for technology usage, but also necessitate the incorporation of effective communication, ethical considerations and the judicious discretion of instructors in the integration of AI technologies (Alba et al., 2025).

As the extant GenAI technologies predicate upon the provision of human guidance to assess digital competencies through the deployment of explainable algorithms, scholars and educators have evinced concerns pertaining to the regulation of such technologies and attendant systems (Svoboda, 2024). Notably, low-income countries have been observed to lag considerably behind their higher-income counterparts, primarily attributable to constraints in digital infrastructure development, human capital formation, and institutional robustness (Khan et al., 2024). Conversely, studies endeavouring to frame novel digital competencies have predominantly centred on the aggregation of self-reported data from stakeholders situated within educational settings. However, this methodological approach is inherently imbued with subjectivity and susceptible to the introduction of bias, thereby rendering the obtained findings challenging to extrapolate beyond the specific contextual parameters in which the research was conducted (Cammaerts & Mansell, 2020).

Several global organizational entities have proffered conceptual frameworks intended to serve as guiding principles for the development of digital competencies within the GenAI era (e.g., OECD, 2023; Russell Group; 2023; UK Department of Education, 2023; U.S. Department of Education; 2023). However, these prescriptive models lack direct engagement with self-reported data acquired from relevant stakeholders (Alfia et al., 2020; Shopova, 2014; Ufimtseva, 2020). Consequently, the gap between awareness and limitations pertaining to practical application has hitherto been underexplored within extant scholarly discourse. Further efforts are required to unify and clarify the conceptualization of digital competencies and develop a comprehensive strategy for cultivating these competencies among students (Abid et al., 2022; UNESCO, 2018; Wang et al., 2024; Zhang et al., 2020).

While the present study acknowledges the prevailing consensus view that digital competencies should encompass an array of critical facets, scholars have engaged in extensive debates regarding the prioritization of specific competencies within a conceptual framework, as well as the evolution of digital competencies over time. The empirical findings emanating from investigations conducted at European universities suggest that prospective graduates are likely to possess only a low-intermediate level of digital competencies, particularly in the domains of multimedia content creation and dissemination across various technological tools (López-Meneses et al., 2020). Furthermore, Ala-Mutka (2011) has underscored the intersectional nature of digital competencies with digital literacy, particularly in areas such as information, technological, and multimedia literacy. Conversely, Janssen and colleagues (2013) have proffered a conceptual framework predicated upon the collective perspectives of subject matter experts. The European Union has summarized extant conceptualizations and proposed the Digital Competencies of Educators (DigComp) framework, which encompasses 22 digital competencies that are categorized into six distinct areas, namely professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competencies (Punie et al., 2014).

Aim of the study

This study aims to address the lack of focus on educational environments that foster digital competencies by identifying the digital competencies prioritized in the regulatory policies of leading universities from an institutional perspective. Specifically, the study intends to address the following two research questions:

1. What digital competencies are included within the purview of university regulatory policies?

2. How do universities conceptualize and delineate digital competencies within the GenAI era?

Method

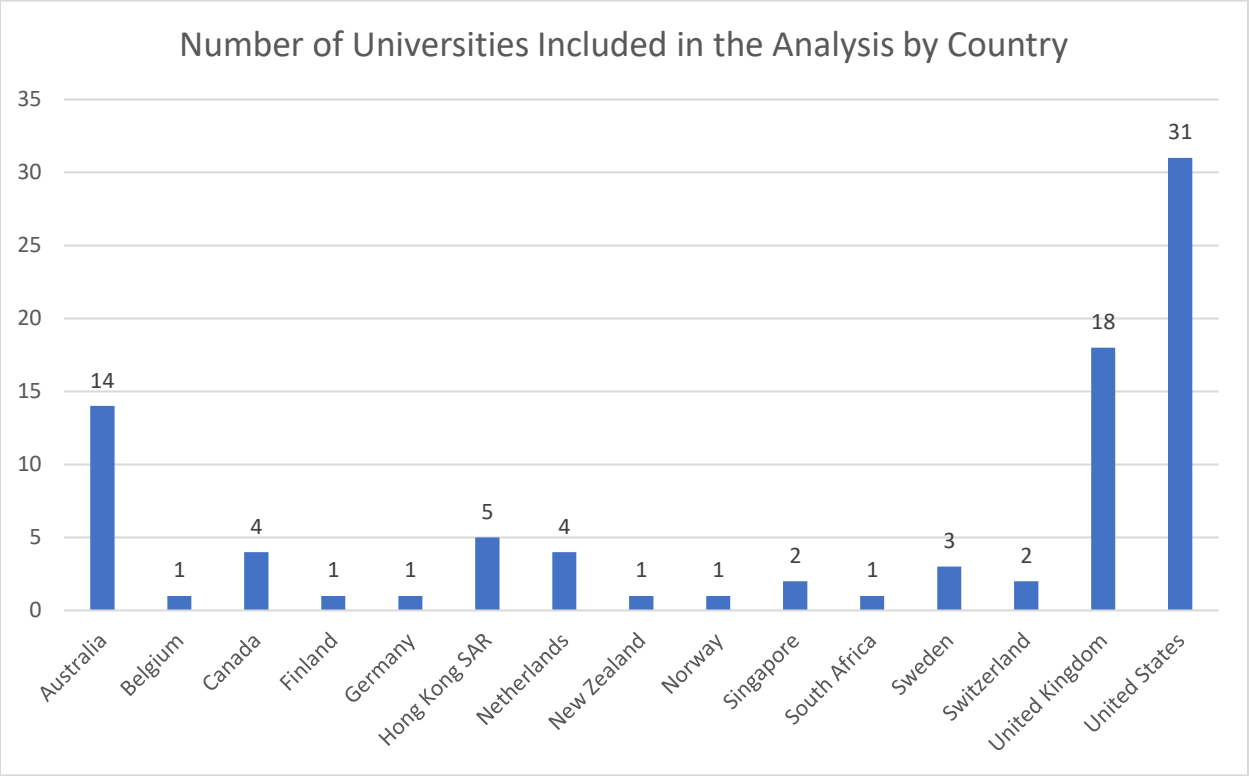
Data collection

To investigate digital competencies and policy implications related to generative AI in higher education, this study analysed regulatory policy documents from world-leading universities, focusing specifically on a sample (Figure 1) of the top 200 institutions from the QS World

University Rankings published in April 2024. The QS World University Rankings is a comprehensive collection of comparative rankings for colleges and universities, serving as a representative tool for selecting world-leading universities. The 2024 edition encompassed 1500 HEIs across 104 locations, taking into account a wide range of factors, including academic reputation, employer reputation, research impact, internationalization, international research network, employment outcomes, and sustainability (QS Quacquarelli Symonds Limited, 2024). The QS higher ranking is indicative of a higher quality of academic and professional output, as well as greater and more sustained contributions to society.

Figure 1

Regional distribution of identified universities



The sample selection method for this study is grounded in the principle of data availability, which is crucial for ensuring that the findings are representative and reliable. Given that the top 200 world-leading universities, as indicated by the QS World University Rankings, have predominantly issued GenAI-related regulation policies that are accessible to the public, this forms the basis of our sample selection. It is assumed that these leading universities are more likely to address higher education challenges and embrace new developments in a timely manner. This approach aligns with the need for transparency and the dissemination of information that is not restricted to private university employees, thereby fostering a more inclusive and open academic environment.

To achieve the objectives of the present study, we conducted a comprehensive search and collection of regulation documents pertaining to the utilization of GenAI technologies, as issued by the top 200 HEIs on the most recent QS ranking list. We conducted purpose sampling and selection for policies and guidelines related to GenAI, utilizing keywords such as 'AI,' 'Generative

AI,' 'ChatGPT,' and their synonyms. This search was performed on the official websites of the selected universities to identify documents pertaining to GenAI. Policies that were not publicly accessible were excluded from our analysis. Through this process, we identified 88 out of 200 universities that have formulated specific guidance and regulations concerning GenAI and its associated technologies. These universities have demonstrated a proactive approach in developing policies to govern the application of GenAI within their academic settings.

Data coding and analysis

Content analysis served as a systematic and detailed technique for investigating the varying degrees of emphasis placed on digital competencies across a diverse range of the HEIs included in our dataset. To further explore the DigComp framework in various educational settings, we employed content analysis for coding and categorizing the qualitative data extracted from each university's regulation documents. This allowed us to identify, comprehend, compare, and scrutinize the key digital competencies outlined in those documents (Carretero et al., 2017).

In order to circumvent the inherent limitations posed by the lack of comprehensiveness within a single conceptual framework, as well as to mitigate the constraints engendered by the self-report data generation process (Mattar et al., 2022; Zhu & Andersen, 2022), this study has adopted a combined framework predicated upon the DigComp 2.1 model developed by the Institute for Prospective Technological Studies (Carretero et al., 2017). The analytical framework concurrently permits the organization of the core competencies comprising the EU DigComp framework according to their perceived level of significance. Accordingly, the following five domains were used to analyse the presence, meanings, and relationships of digital competencies:

(1) Information and digital literacy

(2) Communication and collaboration

(3) Content creation and programming

(4) Safety and cybersecurity

(5) Problem solving and critical thinking

Furthermore, as a part of our analysis, we explored the digital competencies that universities highlighted as particularly essential for students when utilizing GenAI tools, such as ChatGPT, to assist them in completing academic assignments and attaining other learning outcomes. By delving into these specific competencies, we aimed to provide a deep understanding of the educational priorities and considerations related to the integration of GenAI technologies within the learning process.

Prior to commencing the analysis, the qualitative data sourced from the HEIs' policy documents were coded and categorized using MAXQDA software. To illustrate emphasis within the text transcripts, word clouds were generated, which provided a visual representation of the key themes and concepts. To ensure analytical rigor, the analytical findings reported by MAXQDA were triangulated by the two authors. This involved a thorough review of the original document content to validate and verify the identified patterns, themes, and interpretations. The coding keywords and selected content examples are presented in Table 1 for reference and clarity.

Table 1

Coding process and content analysis

Core code	Sub-code keywords	Example of policy content
Information and Digital Literacy	Locate; Retrieve; Store; Summary; Organize; Analyse; Information	Generative AI tools like ChatGPT are capable of processing vast amounts of information to quickly produce an easy-to-understand summary of a complex topic.
Communication and Collaboration	Communication; Share re-sources; Collaborate; Inter-action in communities; Network; Cross-cultural awareness	Our students need to learn unbiased, concise, precise, and factually correct communication.
Content Creation and Programming	Create and edit content; Produce; Integrate knowledge; Creative expressions; Media outputs; Programming	Generative AI tools do not produce neutral answers because the information sources they are drawing from have all been created by humans and contain our biases and stereotypes.
Safety and Cybersecurity	Protection; Ethnical; Digital identity; Security; Safe and sustainable use; Privacy risks; Confidentiality	We have created these new guidelines to support our teams in using generative AI tools safely, ethically and effectively.
Problem Solving and Critical Thinking	Identify needs and resources; Make decisions; Solve problem; Technical problem; Creative; Critical	We may use these tools in a similar way to how we ask a colleague for an idea on how to approach a creative task … pick the best ideas from ChatGPT's response and adapt them.

Results

General trend in the HEI regulations pertaining to GENAI

The analysis of policies and regulations issued by the 88 universities included in our analysis (Figure 1) revealed a high degree of variation in the levels of institutional engagement and regulatory frameworks regarding GenAI technologies across the global higher education landscape. A significant proportion of policies and regulations related to GenAI were issued by universities situated in the United Kingdom, the United States, Australia, Hong Kong, and Northern European countries (Figure 1). These institutions demonstrated a high degree of proactivity by establishing guidelines and frameworks governing the use of GenAI technologies within their academic settings.

Comparatively, universities in China (including prestigious HEIs such as Peking University and Tsinghua University), as well as universities in France (such as L'Université PSL and L'Institut Polytechnique de Paris), and universities in Southeast Asian countries like South Korea and Malaysia, have not yet released any specific policies or regulations related to GenAI. This discrepancy indicates a potential gap in the formalized governance of GenAI technologies within these regions. Although ChatGPT has infinitely broad development prospects, this and other GenAI technologies developed in Western countries are not accessible within mainland China. Accordingly, it is likely that Chinese mainland universities presently see no need for specific policies governing their use by staff and students. It is also worth mentioning that certain

universities, such as The City University of Hong Kong, have opted to maintain confidentiality surrounding their GenAI regulations. As a result, access to these regulations is restricted exclusively to students, and these confidential regulations have been excluded from our analysis.

The analysis of regulatory policy content revealed key patterns and themes that underscore the prevailing trends in GenAI regulations across universities. A word cloud generated from the regulatory documents (Figure 2) highlights the prominent use of ChatGPT as an example in guiding the application of GenAI technologies among students. Furthermore, the regulatory documents consistently identified GenAI as an instrumental aid for students, assisting them in their assignments, assessments, and overall learning progress.

Figure 2

Keywords reported in the regulatory documents of selected universities

Notably, the regulations placed a strong emphasis on information competencies, as evidenced by the 140 instances of the term “information” in the dataset. In this context, competencies referred to the use of GenAI technologies in content input as well as output. Specifically, in relation to content input, focus is given to the ability to locate, retrieve, and summarize relevant materials, while output entails the capacity to effectively summarize, organize, and analyse the gathered information with the assistance of GenAI tools. By highlighting this competency, universities demonstrate their commitment to fostering students’ information literacy and their capacity to effectively utilize GenAI technologies to support their scholarly pursuits.

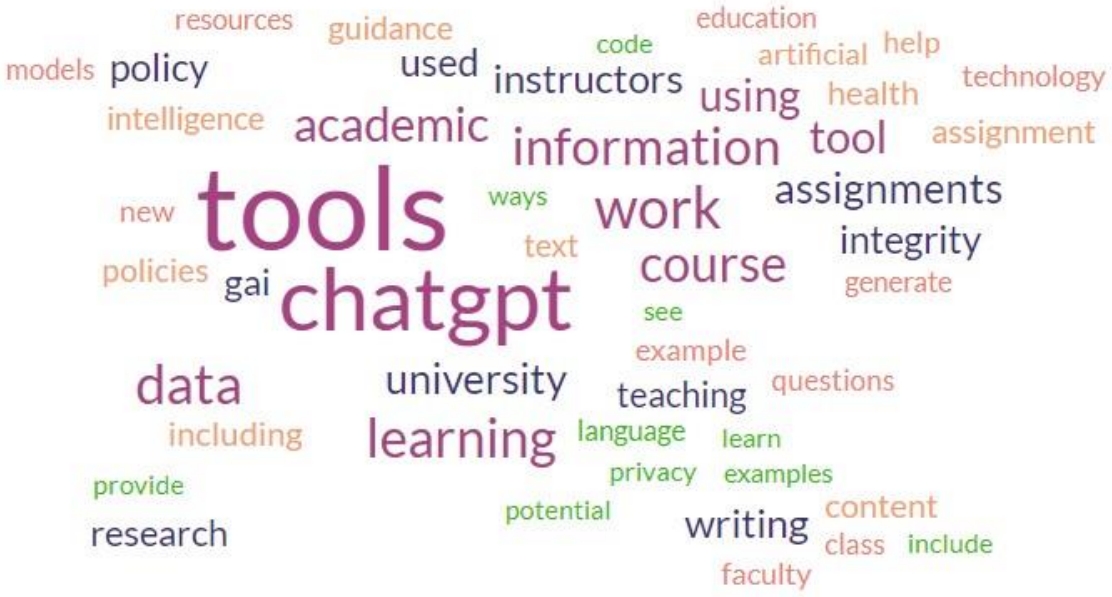
Academic integrity emerged as another significant focus in the majority of regulatory documents, closely linked to student competencies related to safety. Academic integrity encompasses ethical principles and values within the academic environment, including commitments to honesty, originality, respect for intellectual property, impartiality, and the avoidance of bias. It also entails the responsibility and accountability of students for their own academic work. Educators and scholars have frequently raised concerns about violations of academic integrity in the digital era, such as cheating, fabrication, falsification, and plagiarism (Blau et al., 2021). The emphasis on

academic integrity in the regulations reflects universities' commitment to maintaining their professional reputation as well as their desire to foster the safety competencies among their students when utilizing GenAI in their learning processes.

The analysis of regulatory documents also reveals a shared recognition of the importance of integrating GenAI technologies in higher education. Nonetheless, nuanced differences in emphasis on specific aspects (such as "information" or "tools") emerge across regions, providing insights into the varying priorities and approaches to GenAI regulations (Figures 3, 4, and 5).

Figure 3

Keywords reported in regulatory documents of U.S.A. universities

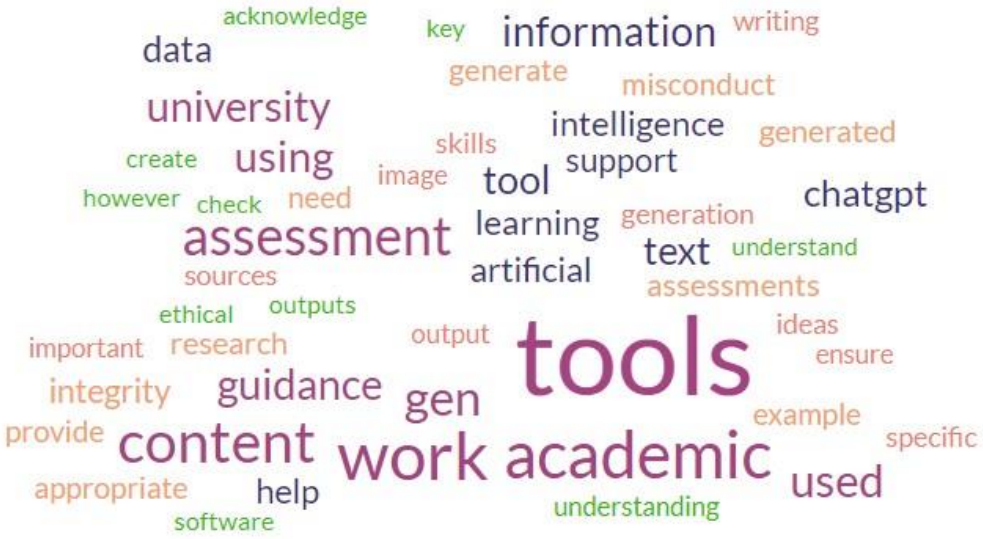


For example, universities in the United States of America (U.S.A.) demonstrate a more balanced emphasis on digital competencies, as evidenced by the higher frequency of keywords such as "information," "learning," "data," "academic," and "research" in their regulatory documents (Figure 3). This finding indicates a comprehensive approach to GenAI integration within the U.S.A. top-tier HEIs, where various aspects of digital competencies are recognized and the significance of GenAI technologies across different educational domains is acknowledged.

Universities in the United Kingdom (U.K.) place particular emphasis on the critical "content" input and output when utilizing GenAI technologies, such as ChatGPT, to generate code, statements, or summaries (Figure 4). The regulatory documents from these institutions also convey the recognition of value that GenAI technologies bring in the content creation context. These findings suggest that the U.K. universities prioritize equipping students with the skills to critically and effectively incorporate information and content while using GenAI tools.

Figure 4

Keywords reported in regulatory documents of U.K. universities



In comparison, the regulatory documents concerning GenAI released by the Australian universities included in our analysis predominantly focus on “research” (Figure 5). A much lower frequency of the term “information” in these documents indicates that content creation competencies, particularly in assisting students in conducting research or related assessments, are seen as the key digital literacy competencies by these HEIs. In sum, Australian universities recognize the role of GenAI technologies in facilitating research processes and encourage students to leverage these tools to enhance their research capabilities.

Figure 5

Keywords reported in regulatory documents of Australian universities

The **information and digital literacy** domain of the DigComp framework includes a variety of competencies, with an emphasis on the capacity to efficiently navigate, search, and filter digital information (Carretero et al., 2017). This was the key competency emphasized in the regulatory documents issued by the top-rated HEIs, as reflected in the guidance pertaining to the role of GenAI in facilitating the generation, retrieval, summarization, and analysis of digital information. Thus, students can use this information as an introductory framework when incorporating GenAI technologies into their daily learning routines. From the document analysis, it is also evident that these universities strive to enhance students' comprehension of GenAI technologies by introducing a diverse array of software applications encompassing text, image, and audio generation. Additionally, the documents highlight the myriad of ways in which GenAI technologies can assist students in their academic pursuits, including answering input questions and producing text aligned with specific prompts.

> When prompted on any topic, it will give an excellent overview of what is out there: the good, the bad, and the ugly, in its typical list style. This can provide an extremely helpful start into essays, presentations, and papers, since it will likely come up with aspects and topics that the human author might not have considered. (ETH Zurich − Swiss Federal Institute of Technology)

Most of the regulatory documents issued by the eminent universities also highlight the importance of **content creation and programming** as well as **problem solving and critical thinking** competencies. Within the DigComp framework, this particular competency is described as the aptitude for generating innovative expressions and creating new digital content. It thus involves the ability to produce creative outputs within the digital realm. The problem-solving and critical thinking competencies focus on proficiency in addressing technical challenges and utilizing technology in a resourceful and inventive manner. In this domain, emphasis is placed on the capacity to analyse problems critically and devise effective solutions, leveraging technology as a problem-solving tool (Carretero et al., 2017).

In order to address potential issues such as plagiarism and academic dishonesty arising from the incorporation of GenAI outputs in academic work, most HEIs also give due consideration to academic integrity in their regulatory documents. This is to be expected, given that the widespread adoption of GenAI has already raised concerns within the academic community regarding the ability to uphold the fundamental teaching and learning values, such as honesty, trust, fairness, and responsibility (Macfarlane et al., 2014). To address these challenges, universities have put forth guidelines to assist students in navigating the usage of content generated by GenAI technologies. Furthermore, they emphasize the significance of critical thinking and the need to assess the validity of the information and content provided by GenAI, as indicated by the following excerpts:

> Any work submitted must represent a genuine demonstration of your own work, skills and subject knowledge, adhere to the guidelines of the assessment task, and respects the university's value of academic integrity and honesty. (King's College London)

> These prompts are requesting the AI to generate specific content or complete your assignment. They go beyond the scope of using generative AI as a tool for a rapid overview and potentially produce autogenerated text, which is not allowed. (KTH Royal Institute of Technology)

Moreover, some universities have imposed explicit limitations on the utilization of GenAI, encouraging students to actively contribute their own insights and ideas while employing this technology as a supportive tool rather than a sole solution. For instance, HEIs may require students to annotate their solutions to novel problems or compose cover letters that introduce their ideas for essays. Additionally, universities may encourage students to present drafts of their work orally in class or track the citations in early versions of their assignments. To mitigate excessive reliance on GenAI in completing assignments, students may also be encouraged to engage in an iterative process of multiple drafts and revisions, thereby demonstrating their personal contribution to the work submitted for grading.

While all the aforementioned findings are quite encouraging, our analysis also revealed some notable gaps in the regulatory documents issued by world-class universities. Specifically, despite ongoing discussions on the cyberthreats that may arise due to the adoption of GenAI technologies (Bécue et al., 2021), these HEIs have not extensively addressed **safety and cybersecurity** as one of the core digital competencies in their regulatory documents.

According to the DigComp framework, safety knowledge encompasses various aspects, including data protection, safeguarding digital identity, taking appropriate safety precautions, and promoting the sustainable and secure use of technology (Carretero et al., 2017). Although it is important to make students aware of the need for critical analysis of output created by GenAI, equal attention should also be given to ensuring the safety of content provided as input to the GenAI systems. This aspect entails understanding and addressing potential risks associated with data privacy, protecting personal information, and adopting measures to ensure the responsible and secure use of technology, as outlined below:

> There are risks to privacy and intellectual property associated with the information we enter into these tools. The Terms of Use in many AI tools are not clear on how the inputs are stored or may be accessed in the future. We must only input information that is already in the public domain. We will not input any confidential or restricted data, in the same way that we do not share this on social media, in an external email, or discuss in public. (University of Cambridge)

Significantly, the regulatory documents targeted at students in the HEIs included in our analysis usually overlook the importance of **communication and collaboration** competencies. Communication is a fundamental aspect of digital competencies, encompassing various tasks such as interacting with technology, sharing content and information, collaborating with others through digital channels, and managing one's online presence (Carretero et al., 2017). While some universities recognize the significance of communication and collaboration competencies in the implementation of GenAI technologies, the focus is primarily on involving educators in the process, as exemplified below:

> By combining human and artificial intelligence; by means of educators and students working together to co-design, test, assess, and share … by establishing interconnected communities of practice within the university and globally to utilise emerging technologies. (Monash University)

In contrast, explicit guidance or suggestions on how students can effectively engage with technologies and collaborate with their peers when applying GenAI in their studies is rarely provided in the regulatory documents. Moreover, even when these aspects are considered,

documents tend to fall short in outlining the specific strategies and skills needed for students to navigate communication and collaboration when utilizing GenAI technologies. To comprehensively nurture digital competencies, it is crucial for universities to address these shortcomings.

Discussion

The findings yielded by this study indicate that, in most HEIs, digital competencies are recognized, as many world-class universities have developed regulatory documents pertaining to GenAI use when searching, evaluating, retrieving, and managing digital information, directly or indirectly, for professional practice and development. Accordingly, these HEIs have embraced their responsibility for exposing their students to the latest technologies, and are equipping them with relevant knowledge in the realm of digital information. At present, focus is primarily given to the following areas: (1) developing students' understanding of the nature of digital information and the diverse GenAI technologies applicable to different professional practices; (2) cultivating students' ability to search for, locate, retrieve, use, and ethically manage pertinent data and information for professional development and informed decision-making; and (3) ensuring the maintenance of academic integrity and the ability to evaluate the integration of GenAI technologies into academic work.

In the regulatory documents examined as a part of this study, digital communication is given comparatively less emphasis than other aspects of digital competencies, despite safety and academic integrity issues related to digitalization being prominent topics of discussion among professionals and practitioners in global HEIs (Wang et al., 2023). As our analyses demonstrate, only certain universities recognize the significance of digital security, including concerns such as confidentiality, plagiarism, online risks, and the blurring of personal and professional boundaries. In this context, it is also worth noting mixed research findings regarding the prevalence of academic dishonesty in the online environment. Despite the issues of biased algorithms and AI-driven decision-making being recognized, they remain insufficiently explored and require more in-depth investigation (Slimi & Carballido, 2023).

Our study further underscores the need to advocate for institutional leadership in balancing academic integrity with AI-enhanced learning, particularly in the context of students' engagement with GenAI methodologies and frameworks. The study further highlights that this gap needs to be addressed, and the definitions of values and integrity also require a revision to reflect their meaning in the digital era (Chankova, 2020; Holden et al., 2021). For example, this could entail updating institutional honour codes to specifically address the misuse of AI and utilising algorithmic auditing tools, like Turnitin's AI detection software. As suggested by constructivist learning theory, HEIs have to take into account AI technologies as scaffolding mechanisms that allow students to participate in active, self-regulated learning processes (Grubaugh et al., 2023). In addition to formative assessments that emphasise the development of critical thinking abilities over the simple production of rote outputs, such measures would aid in ensuring structural accountability and promote a culture of true intellectual honesty.

The empirical evidence presented in this study highlights the imperative for policymakers and educational practitioners to prioritize digital safety concerns and collaborative pedagogical frameworks within contemporary educational settings. The integration of "AI-driven learning" technologies, such as Automated Performance Enhancement, Intelligent Tutoring Systems, and Personalized Learning Systems, into diverse educational domains is trending. These

technologies are capable of providing tailored feedback on written assignments, aiding with technical and navigational challenges, and offering language translation services. It is imperative to acknowledge that GenAI techniques are not intended to supplant human interaction or the specialized knowledge and mentorship of human educators. Instead, they should be viewed as supplementary tools. Consequently, it is essential for educators to integrate technological proficiency with both pedagogical design and teaching expertise. Strategically designed workshops, online training courses, and structured professional development seminars can serve to equip faculty members with the requisite multifaceted skillset necessary to effectively incorporate AI technologies into their teaching methodologies. This, in turn, will better position instructors to mentor students on the responsible and ethical utilization of AI-powered tools and applications (Escotet, 2023).

Recent scholarly work also suggests that there is a pressing need for HEIs to provide clearer guidelines regarding the use of GenAI to address issues of responsibility, equity, and knowledge (Chan & Hu, 2023). It is essential for the institutional instructions to address the concerns of data privacy, accountability, transparency, and equity. Experiential learning pedagogies, including guest sharing and case analyses could provide higher education managers with effective strategies to raise awareness of the multifaceted risks associated with AI technologies. Universities could also consider strategic partnerships with cutting-edge research centres and enterprises to develop and conduct a joint outline for GenAI regulatory policies.

This study has underscored the challenges wrought by the fragmented policy landscape governing the use of GenAI technologies across diverse regional and institutional contexts. In response, the formulation of a uniform GenAI policy, grounded in the identified digital competencies, could benefit the fragmented framework. The findings further suggest that organizations located in geographically proximate regions or sharing similar socioeconomic development statuses tend to exhibit isomorphic policy adoption patterns. While standardized policy instruments can facilitate seamless inter-institutional policy learning and transfer and maintain academic quality standards, it is crucial to strike an appropriate balance between policy consistency and institutional autonomy. Affording flexibility for contextual accommodation of unique resource constraints and organizational exigencies is paramount. The regulatory policies adopted by HEIs must be inclusive, catering to students from all backgrounds, particularly those from disadvantaged communities, to prevent the exacerbation of educational inequalities (Ahmad et al., 2023).

From this perspective, accreditation organizations and inter-university consortia can play a key role in taking the lead in developing and disseminating these standardized GenAI policy frameworks. By promoting collaborative and participatory policymaking, higher education stakeholders can foster a cohesive and equitable ecosystem for the responsible use of GenAI technologies to benefit the broader academic community.

Limitations

Notwithstanding the valuable insights yielded by the present research, it is essential to acknowledge the limitations of the study and propose avenues for further exploration within future research endeavours. The authors acknowledge limitations inherent in the study’s scope, including the exclusion of non-English-language policies and inaccessible documents. These omissions, which lie beyond the research team’s capacity to address, may have influenced the generalizability of findings and warrant cautious interpretation of results.

It should also be noted that the analysis of regulatory policies issued by a subset of top-tier universities reflects the intended situation rather than the actual hands-on practices in teaching and learning. Additionally, although our study contributes to the discussion of the range of digital competencies students should develop, the sample size utilized is relatively small. Both of these shortcomings can be mitigated in future studies by collecting firsthand empirical data from educators and students across various institutions.

This study's content analysis of regulatory documents provides an overall picture of technology-mediated teaching and learning practices within the selected HEIs. Future research is thus needed to gather additional evidence from diverse institutions to draw a more comprehensive understanding of the digital competencies' requirements for students from different backgrounds and at different educational levels.

This study lays a basic foundation for developing informed policies and practices that empower students to acquire the essential skills and competencies needed to thrive in the digital era. Future research endeavours would benefit from further exploring generative AI literacies, interdisciplinary competencies in innovative pedagogies, and their respective evaluation mechanisms. Such exploration would contribute to a more comprehensive understanding and effective integration of generative AI technologies in educational contexts.

Conclusion

Based on the findings of this study, we argue that effective implementation of AI tools in education requires comprehensive digital competencies from both teachers and students. A comprehensive digital competencies framework should encompass technical skills, communication capability, pedagogical strategies, and supporting infrastructure. Robust data governance protocols, coupled with intentional efforts to bridge technological access divides, will be essential for ensuring the equitable distribution of the benefits conferred by emerging digital tools and AI-enabled educational innovations.

Notably, the development of critical perspectives and reflective capacities is increasingly vital for educators and students engaging with GenAI and related digital technologies. Correspondingly, it is of vital importance that HEIs implement robust assessment methodologies to rigorously evaluate whether the digitalization initiatives undertaken contribute to tangible improvements in the quality and inclusivity of student learning outcomes, or if they inadvertently impede such developments. Such assessment protocols should prioritize the systematic collection and analysis of empirical data, affording higher education stakeholders the requisite insights to refine and optimize their technology-enabled teaching and learning praxis.

Additionally, the necessity to strike a balance between regulatory oversight and the provision of high-quality educational experiences has to be taken into account during the policy development process. When developing such policy directives, policymakers have to consider the diverse institutional priorities that shape the unique pedagogical needs and strategic aspirations of various higher education stakeholders. For instance, liberal arts universities may priorities the development of interdisciplinary humanities competencies over the development of narrowly specialized cyber-related skill sets, whereas private and public institutions may articulate significantly different strategic foci and operational mandates.

Moreover, recognizing and addressing digital exclusion is crucial to enhancing students' capacity to participate in a digital society. Targeted policies should adequately reflect the myriad ways in

which students from diverse socioeconomic and cultural backgrounds leverage GenAI-powered tools and engage with various digital platforms and modalities of communication. It is noteworthy that the majority of universities in this study used ChatGPT as an illustrative example when formulating regulations and policies related to GenAI. However, universities in less developed countries and regions are to some extent being isolated from the global digital networks as limited internet access or digital learning resources go hand-in-hand with national security concerns (e.g. firewalls). It calls for a rethink of how to expand access to these platforms to everyone regardless of linguistic and geographical background (Farrelly & Baker, 2023).

Attainment of these goals requires a comprehensive approach that considers the information, communication, creation, safety, and problem-solving dimensions associated with digitalization, fostering an environment where students are equipped with strong digital competencies to adapt and thrive in the digital era (Nowak, 2019; Guil-lén-Gámez & Mayorga-Fernández, 2020). Future education management and guidelines should incorporate AI-based adaptive learning algorithms that can customize content and feedback based on individual student performance and learning styles. The addressing of relevant issues related to digital inequity and privacy violations should be acknowledged as a critical institutional priority.

Given the differing priorities in AI-based policies and regulations across universities highlighted in this study — some emphasizing academic integrity while others prioritizing innovation and use-case freedom future research could develop a typology or taxonomy of these policies for deeper analysis. Such research could lead to policy interventions prioritizing infrastructure development in underserved regions, subsidizing affordable connectivity solutions, and integrating digital literacy programs to empower marginalized populations. Concurrently, this study highlights the importance of researching how data governance protocols can address algorithmic bias, ensure transparency in AI decision-making processes, and establish accountability mechanisms to safeguard equitable outcomes. A holistic approach combining these elements is proposed to foster inclusive participation in the digital economy and bridge the divide between technologically enabled opportunities and socio-economic exclusion.

Acknowledgements

The authors disclose that they have no actual or perceived conflicts of interest.

This research was funded by the Beijing Municipal University Teacher Team Construction Support Program "Outstanding Young Talent Cultivation Program" (Fund No. BPHR202203027), and 2019 Beijing higher education undergraduate teaching reform and innovation program (Fund No. 162).

As per Crawford et al. (2023), the authors have not used artificial intelligence in the ideation, design, or write-up of this research and confirm that they have met the ethical standards expected as per Purvis & Crawford (2024). The authors list the following CRediT contributions: Both authors have contributed equally to the manuscript and would like to be recognized as joint first authors. Conceptualization, Y.Z and Z.T.; Methodology, Z.T.; Software, Z.T.; Data analysis, Z.T and Y.Z; Resources, Y.Z.; Data curation, Z.T.; Writing—original draft preparation, Z.T.; Writing—review and editing, Y.Z.; Visualization, Z.T.

The authors also express their sincere gratitude to Ms. Ma Tongfei for her assistance in verifying the original data and coding materials utilized in this study.

All authors have read and agreed to the published version of the manuscript.

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