

Opportunities, challenges and school strategies for integrating generative AI in education

Davy Tsz Kit Ng^{a,*}, Eagle Kai Chi Chan^b, Chung Kwan Lo^a

^a Department of Mathematics and Information Technology, The Education University of Hong Kong, Hong Kong, China

^b Division of Integrative Systems and Design, The Hong Kong University of Science and Technology, Hong Kong, China

ARTICLE INFO

Keywords:

Artificial intelligence
Generative AI
Teacher education
Learning/teaching
School improvement
School policy
School management

ABSTRACT

The increasing accessibility of Generative Artificial Intelligence (GenAI) tools has led to their exploration and adoption in education. This qualitative study investigates the opportunities and challenges associated with integrating GenAI in education, and the strategies that encourage teachers and students to embrace GenAI in school settings. We recruited 76 educators in Canada to participate in a professional training seminar about GenAI and expressed their views through online surveys. Through written reflections, an optimistic outlook on GenAI's role in education was identified among the teachers, and some discipline-specific ideas were proposed. Thematic analysis reveals three key practices of AI implementation: teaching/learning, administration and assessments. However, three major challenges are also identified: school's readiness, teachers' AI competencies, and students' AI literacy and ethics. Teachers suggest several strategies to motivate GenAI integration, including professional development, clear guidelines, and access to AI software and technical support. Finally, Singh's Teach AI Global Initiative Guidance and Socio-ecological Model are adapted and proposed to support schools in becoming AI-ready by addressing teachers' and students' needs, facilitating organizational learning, and promoting improvement and transformation to foster their literacy development. Recommendations were provided for developing effective strategies to embrace GenAI in education.

1. Introduction

Generative artificial intelligence (GenAI) has emerged as a disruptive technology with the potential to education by offering new opportunities for personalized learning, content creation (e.g., images, audio, videos), data analysis, and program code generation (e.g., Chiu, 2023; O'Dea et al., 2024). Artificial intelligence (AI) often mimics human cognitive functions such as learning and problem-solving by using human-designed rules to analyze data, interpret inputs, and achieve specific goals (Siemens et al., 2022; Ng et al., 2024). GenAI is a type of AI technology that automatically generates content in response to prompts in natural-language conversational interfaces (UNESCO, 2023). Its core are pre-trained large language models (LLMs) that use vast datasets from the Internet, social media conversations and other databases and sources to produce human-like contents in various conversational formats based on natural language inputs (Yan et al., 2024).

The differences between traditional AI and GenAI are significant. Laviola et al. (2024) pointed out that not all AI is created equal. The differences are categorized across six dimensions: data sources,

responses, interactivity, contextual understanding, task completion, and technical requirements. First, in terms of data sources, traditional AI typically relies on structured data from predefined datasets and historical data to make decisions, often resulting in rule-based responses grounded in programmed logic and trained patterns (Ng et al., 2024). In contrast, GenAI utilizes vast amounts of unstructured data from the Internet and other diverse sources to produce human-like responses in various formats such as text, images, and videos. While traditional AI usually depends on pre-programmed responses, GenAI tends to be more interactive, facilitating conversational exchanges and enabling more personalized responses based on user prompts. Furthermore, traditional AI often struggles with understanding context beyond specific parameters, whereas GenAI exhibits more advanced contextual understanding, interpreting nuanced language and generating contextually relevant responses (Samala et al., 2024). In terms of task completion, traditional AI is effective at handling well-defined tasks like data analysis and automation, while GenAI excels in more complex problem-solving, often generating solutions that were not explicitly programmed. Lastly, the technical requirements for developing traditional AI solutions

* Corresponding author.

E-mail addresses: davyngtk@eduhk.hk (D.T.K. Ng), kcechan@connect.ust.hk (E.K.C. Chan), chungkwanlo@eduhk.hk (C.K. Lo).

<https://doi.org/10.1016/j.caeai.2025.100373>

Received 30 May 2024; Received in revised form 22 January 2025; Accepted 23 January 2025

Available online 25 January 2025

2666-920X/© 2025 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

necessitate a deeper understanding of AI concepts and programming skills, along with upfront configuration, including data labeling and model training. GenAI requires other competencies such as critical thinking skills and prompt engineering techniques to fine-tune its responses, allowing for more accessible setup and engagement (O’Dea et al., 2024). As such, unlike traditional AI, GenAI learns from user-inputted responses (e.g., data and prompt), and adapts its behavior based on discovered patterns, creating content that resembles human-generated outputs (Borah et al., 2024). Table 1 displays the differences between traditional AI and GenAI.

The literature review section first reviews the opportunities and challenges associated with GenAI in education, and discusses how teachers apply GenAI for teaching/learning purposes. Second, schools consist of diverse stakeholders (e.g., school leaders, teachers) who hold varying views towards GenAI. The second part will review the perceptions of these stakeholders regarding the impact of GenAI technologies on education based on prior research. Finally, the third section will examine existing school strategies that can promote the development of AI-ready schools.

1.1. Opportunities and concerns of using GenAI in education

Recent reviews have identified numerous opportunities and concerns for integrating GenAI, particularly ChatGPT, in education. For example, Levin et al. (2024) provided empirical evidence from 19 studies demonstrating its usage in assessments, suggesting that similar GenAI applications could enhance knowledge acquisition across subjects. Lo (2023) examined 50 articles and identified ChatGPT’s potential as both an instructional assistant and a virtual tutor, tailored to diverse educational needs. Vargas-Murillo et al. (2023) emphasized its capacity to streamline student learning processes, and prevent the over-reliance on AI outputs. Zhang and Tur (2024) asserted that ChatGPT can empower educators in curriculum development and personalized learning, although concerns about academic integrity and content quality must be addressed. Lo et al. (2024) emphasized the role of ChatGPT in fostering students’ emotional, behavioral, and cognitive learning engagement by reviewing 72 studies. ChatGPT fosters positive feelings, satisfaction, and enjoyment among students. By facilitating AI-student interactions, it

Table 1
Differences between traditional AI and GenAI.

	Traditional AI	GenAI
Data sources	Relies on structured data from predefined datasets. Typically uses historical data to make decisions.	Utilizes vast amounts of unstructured data from the Internet and other sources to generate new content.
Response	Tend to offer rule-based responses based on programmed logic and trained patterns.	Generates human-like responses in conversational formats like images, texts and videos.
Interactivity	Depends on how users pre-program its responses; often operates in a reactive manner based on user input.	Highly interactive, allowing for conversational exchanges and adaptive learning based on user prompt.
Contextual understanding	Often struggles with understanding context beyond predefined parameters; relies heavily on specific user inputs.	Exhibits advanced contextual understanding, capable of interpreting nuanced language and generating responses that consider broader context.
Task completion	Effective at completing specific, well-defined tasks (e.g., data analysis, automation).	Excels at creative tasks and complex problem-solving, often generating solutions or content that were not explicitly programmed.
Technical requirement	Requires AI knowledge, technical skills, upfront configuration, including data labeling and model training.	More critical thinking skills and prompt engineering techniques to fine-tune and access GenAI’s responses with less initial setup.

enhances participation, effort, study habits, task completion, and encourages students to self-regulate and invest more time in their assignments at home. Additionally, it improves students’ understanding of knowledge and their self-perception.

Roles of GenAI. GenAI is implemented into various educational roles to enhance teaching and learning. For teachers, GenAI can serve as an instructional co-designer by assisting teachers in developing learning materials such as presentation slides, worksheets, and lesson plans. For example, Cooper (2023) explored how ChatGPT can help educators create learning rubrics and quizzes. Another study conducted by Moundridou et al. (2024) examined its potential to enhance learning content creation, assessment, and activity design within inquiry-based learning frameworks. Additionally, ChatGPT acts as a valuable educational evaluation tool, offering insights and diverse perspectives to make arguments and statements (Herbold et al., 2023). Educators can assign roles to GenAI to explore narratives from various perspectives (Ryazanov et al., 2025) and generate survey questions to gather student feedback (Jansen et al., 2023). For students, GenAI serves as a tutor to provide personalized guidance, adapting to individual student needs. For instance, Gayed et al. (2022) highlighted ChatGPT’s effectiveness as a writing assistant in English language education to enhance students’ performance and reduce their language barriers. GenAI can also serve as a project tool, teammate and expert, offering feedback and resources that are useful for project-based learning (Zheng et al., 2024). It can provide recommendations for students’ projects and reinforce students’ practical skills and knowledge application. Other researchers view GenAI as language tutors (Lo et al., 2024), and learning companions that support students’ learning motivation and self-regulated learning in science education (Ng et al., 2024).

However, it is crucial to acknowledge the limitations of GenAI, including its inability to understand real-world contexts and the potential inaccuracies in its outputs (Chiu, 2023), and However, it also presents challenges, such as a potential reduction in critical thinking skills and an overreliance on AI. While it may generate fluent responses, students with a solid grasp of the subject are better equipped to identify errors. Ethical considerations, such as responsible use of AI-generated content and maintaining academic integrity, must also be addressed (McDonald et al., 2024). Furthermore, biases inherent in the training data can lead to perpetuating stereotypes in educational content. Successful integration of GenAI in the classroom necessitates that school educators and students develop the skills to utilize these tools effectively (Chiu, 2023), including fostering new ideas and creating diverse examples. As discussions around GenAI evolve, it is essential to prioritize ethical principles alongside its technological potential for school students through AI literacy courses (Kong et al., 2024). These courses equip students with essential competencies to understand the fundamental principles of AI, use AI responsibly, evaluate its recommendations critically, and create AI-related artifacts (Ng et al., 2021). While GenAI can facilitate teaching/learning, it is vital to critically evaluate AI-generated resources and adapt them to specific contexts. It is supported by recent studies like Authors (2024) who emphasized the importance of assessing the usefulness of ChatGPT’s explanations and verifying sources rather than relying solely on AI responses. Another study conducted by Zhang and Tur (2024) also pointed out the need to evaluate ChatGPT’s recommendations so that educators could examine the accuracy, contextual relevance, and potential biases in AI-generated contents.

1.2. Perceptions towards GenAI

The integration of GenAI in education has garnered increasing attention among various stakeholders in the educational ecosystem. This section of the literature review explores the perceptions of teachers and school leaders toward GenAI and its implications in the educational context.

Educational leaders, including principals and school directors, play a

critical role in driving educational change and fostering a supportive environment for technological integration (Roth & Price, 2016, pp. 195–213). To implement AI in education, their perceptions towards GenAI are instrumental in shaping school policies, fostering teacher basic competencies, and creating a culture of innovation (Chan & Hu, 2023). Studies indicate that educational leaders perceive GenAI as a transformative force that can enhance student engagement, personalized learning, and instructional effectiveness. They recognize the potential of AI tools to support teachers in delivering differentiated instruction, facilitating data-driven decision-making, and making policies (Wang, 2021). However, concerns related to accessibility of GenAI infrastructure, and related school policies, and teacher professional development in GenAI implementation have also been raised (Knight et al., 2023).

Teachers, as frontline implementers of educational practices, hold valuable insights into perceptions of GenAI. Research suggests that teachers' perceptions of GenAI are diverse and influenced by various factors. Some teachers view GenAI as a tool that can enhance instructional delivery, automate their routine administrative tasks, and provide personalized learning experiences. They recognize the potential of AI in adapting instruction to individual student needs, promoting critical thinking skills, and facilitating real-time feedback (Chen et al., 2020; Kohnke et al., 2023). Moreover, GenAI can enhance learning assessments by enabling self-assessments, automated grading and providing instant feedback, enabling teachers to focus more on individual student growth (Yang et al., 2024). Additionally, it can analyze student performance data to identify learning gaps and patterns, helping educators tailor their interventions more effectively (Jaboob et al., 2024). However, other teachers may express concerns about the impact of GenAI on their professional autonomy, the potential for replacing human interaction, and the need for adequate training and support in integrating AI tools effectively (Rudolph et al., 2024). Teachers' perceptions of GenAI are shaped by their pedagogical beliefs, technological readiness, professional development opportunities, and the alignment of AI integration with their instructional goals (Moorhouse & Kohnke, 2024; Yan et al., 2024).

Overall, the perceptions of school leaders and teachers towards GenAI in education are multifaceted. While there is generally an optimistic outlook towards the potential benefits of GenAI, concerns regarding privacy, equity, and professional development need to be addressed to ensure a successful integration of AI technologies in educational settings. This study examined teachers' perceptions to determine whether the situation in Canada aligns with the current literature.

1.3. School's readiness to bring AI into education

In general, GenAI is claimed to be useful; are schools ready to adopt this? To become AI-ready schools, strategies need to be implemented. According to the UNESCO (2023)'s guide, schools should develop and implement frameworks and guidelines to facilitate responsive and creative use of GenAI in several ways: (1) Developing an ethical framework to support teachers and students in using GenAI responsibly, ethically, and critically to validate the outputs; (2) Providing guidance and training to ensure teachers and students are prepared to use GenAI, including prompt engineering and understanding potential biases such as data privacy and intellectual property; and (3) Detecting plagiarism in written assignments through the use of various GenAI tools. As such, clear guidelines and policies need to be established to ensure the responsible use of GenAI in educational settings, addressing issues such as plagiarism, bias, and data privacy.

Other studies also suggest the importance of curriculum integration and professional development. Curriculum integration plays a crucial role in incorporating AI-related concepts and effectively utilizing GenAI skills across various subjects, equipping students with the necessary knowledge and understanding of the ethical implications behind, and

critical thinking in the context of GenAI (Yang, 2022). Moreover, to prepare teachers to become ready, professional development programs are essential to train them in using GenAI tools wisely, understanding their capabilities and limitations, and developing effective teaching strategies that leverage the potential of GenAI (Yue et al., 2024). By adopting these strategies, schools can foster a digital learning environment that embraces GenAI, preparing students for an AI-driven future while maximizing the benefits and minimizing the challenges associated with this transformative technology.

Most current discussions have focused on higher education, leaving the integration of GenAI in high school settings relatively under-discussed. Schools may not have the necessary resources or readiness to effectively adapt to the changes brought about by GenAI. Additionally, compared to university students, elementary and high school students may require more guidance and support when incorporating GenAI into their learning due to their potential lack of self-regulation (Yan et al., 2024).

A research gap exists in the lack of empirical studies investigating how GenAI has transformed school education. Therefore, this qualitative study aims to explore how teachers perceive and adopt GenAI in school education and suggest strategies for schools to create a positive AI-ready environment, as viewed by school teachers and leaders. Some research questions are as follows.

RQ1: How do teachers' perceptions of GenAI vary across different subjects and experience levels, and what perceived opportunities do they associate with its use?

RQ2: What challenges and concerns do teachers perceive when integrating GenAI in their schools?

RQ3: What school strategies do teachers suggest to embrace the integration of GenAI in their schools?

2. Preliminary framework for analysis

Recent scholars have started developing preliminary frameworks for integrating GenAI in education. For example, Chiu (2023) proposed an initial framework consisting of four dimensions (learning, teaching, assessment, and administration) to examine the impact of GenAI on practices, policies, and research directions in education. The framework employed ChatGPT and Midjourney as case studies. In this study, RQ1 adopts this Chiu (2023)'s model to examine Canadian teachers' thoughts and perceptions towards GenAI usage in terms of perceived opportunities and concerns. After that, RQ1 also presents teachers' perceptions according to their subject disciplines. Regarding RQ2, this study employed the socio-ecological model (Singh et al., 2023) to investigate the challenges and concerns encountered by teachers during the integration of GenAI in their schools. The model inspires us to highlight three themes, which encompass meso and micro perspectives. Furthermore, RQ3 investigates effective school strategies for integrating GenAI. As for RQ3, drawing inspiration from Singh (2023)'s Teach AI Global, this study adopts the framework to inform how schools should be prepared to become AI-ready. The framework encompasses three dimensions: (1) developing guidance and policies that address the specific needs of the school, (2) facilitating organizational learning, and (3) promoting continuous improvement and transformative practices to enhance both teachers' and students' AI literacy.

To summarize, this study designed an initial framework based on three frameworks: Chiu's (2023) four-dimensional model, the socio-ecological model, and the Teach AI Global Initiative Guidance (2024). These frameworks introduced three major themes and nine sub-themes that corresponded to the three RQs in a coding table (Appendix 1). They provided an initial framework for data collection and analysis in this study (Fig. 1).

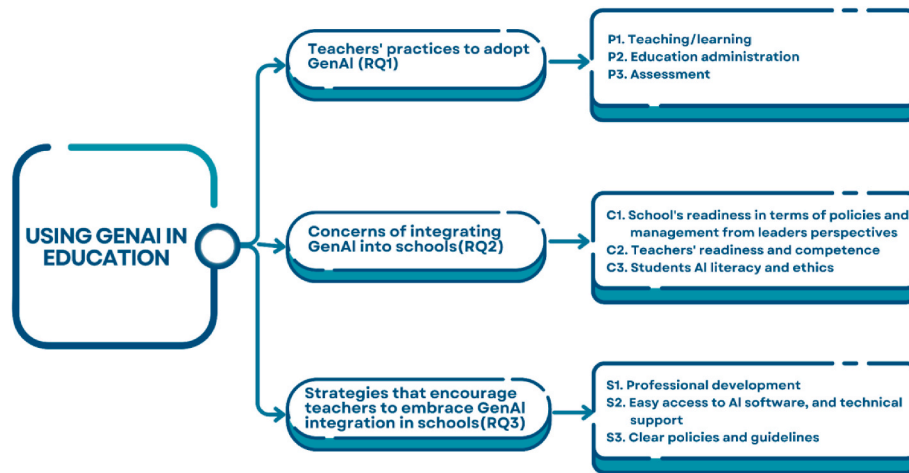


Fig. 1. Initial framework for this study.

3. Research methods

3.1. Participants

This study employs a qualitative research design to gain an in-depth understanding of teachers' reflections regarding the integration of GenAI in the classroom. Qualitative methods are well-suited to explore emerging phenomena and capture the richness of participants' experiences and perspectives (Tracy, 2024). It aims to identify the opportunities, challenges, and school strategies to integrate GenAI in the classroom from the perspectives of teachers.

This study invited hundreds of teachers from twenty schools to complete an online qualitative survey after attending a teacher education seminar about AI education in Canada. There are hundreds of participants. At the end, 73 teachers and 3 school leaders (including a principal, director of instructional innovation, director of athletics) voluntarily completed the survey. The demographic information of the teachers is displayed in Table 2. The seminar provided training for educators to learn what AI and GenAI are, the working mechanisms, and the ethical concerns behind them. The participants shared their

experiences in adopting GenAI in their teaching/learning, administration, and assessments in the seminar.

For example, a teacher participant shared how to use ChatGPT to provide useful recommendations via prompting to improve students' design of mobile applications in computer lessons. Teachers also discussed how they adopted GenAI in teaching and administration, and the challenges and concerns behind it. They then shared how schools and governments could support them to integrate GenAI into their schools. This study used two stages to collect the participants' views. After asking about teachers' demographic characteristics and their prior understanding of GenAI, some open-ended questions were asked to investigate staff's readiness and concerns when integrating AI into education. The self-reported survey was expected to be completed within 30 min.

3.2. Instruments

The instrument in this study was designed to address specific aspects related to teachers' perceptions of integrating GenAI in the classroom. In the self-reported survey, some open-ended questions (e.g., What factors would encourage you to integrate AI into your teaching practices?) were asked. Data will be collected through written reflections, which allow for open-ended exploration of participants' perceptions, experiences, and insights. The survey consists of four sections. First, teachers' demographic information was collected to learn about teachers' background, including educational roles, teaching experience, gender, subject area expertise, and familiarity with technology in education. This section aims to establish a profile of the participants and provide contextual information for data analysis. Then, the survey assessed teachers' general understanding of AI and its potential applications in education. The survey explored teachers' awareness of existing AI tools or platforms in education, and their perception of the benefits and concerns associated with AI integration.

In the second section (RQ1), teachers shared their perceptions of GenAI in their daily work in terms of perceived opportunities and concerns. They responded to questions such as what aspect of AI in education has caught their attention or raised concerns in their daily teaching practice. Furthermore, they provided insights on the challenges and concerns they perceive when integrating GenAI in their schools. In the third section (RQ2), they were asked about their foresight regarding the future role of AI in education and how they think it will impact teaching and learning. They were also prompted to express any concerns they have regarding the integration of AI in education. In the fourth section (RQ3), the study focused on investigating the school strategies that teachers suggested for embracing the integration of GenAI in their schools. The questions aimed to elicit teachers' insights and recommendations on effective approaches for incorporating GenAI into their

Table 2
Demographic information.

Items	Number	Percentage
Gender		
Male	43	56.6
Female	33	43.4
Years of teaching		
More than 10 years	46	60.5
6–10 years	18	23.7
1–5 years	10	13.2
Less than 1 year	2	2.6
Professional teacher training related to AI		
Yes	48	64.5
No	28	35.5
Experience in using AI in education		
Yes	35	46.1
No	33	43.4
Not sure	8	10.5
Major subjects taught		
English and second language	15	20.3
Mathematics and science	12	16.2
Arts, social studies and humanities	12	16.2
Computer science and technology	11	14.9
Others (e.g., business, sports, agriculture, food)	9	12.2
Perhaps not to say	15	20.3
School management without teaching subjects	2	2.7

educational institutions. This helps gather teachers' perspectives on how schools can successfully integrate GenAI into their daily practices.

3.3. Data analysis

To analyze the data, the first two authors were responsible for categorizing the written data. Inductive thematic analysis was adopted, and patterns of similar meanings were grouped into themes based on the research questions. Initially, a process of familiarization with the data will be undertaken by reading and re-reading the transcripts. Then, initial codes will be generated to identify patterns, themes, and categories within the data. These codes will be refined through an iterative process, and themes will be organized into a potential framework. The analysis involved comparison and discussion among the first and second authors to ensure reliability. Initially, 440 data points were collected from teachers' reflections for familiarization, initial, and subsequent coding. Corresponding text segments were then categorized according to the coding schemes for each research question. The first and second authors independently coded 29.5% of the data (130 responses from 22 teachers) before calculating the Kappa coefficient. Inter-rater reliability was assessed using Cohen's kappa coefficient, yielding a score of 0.78, indicating good agreement (Watkins & Pacheco, 2000). The findings will be presented using descriptive and interpretive approaches, supported by quotes from participants. Subsequently, Monkeylearn software was deployed for further analysis. This software is specifically designed for qualitative sentiment analysis and utilizes textual analysis models to automatically tag data, including sentiment and key ideas (Sadriu et al., 2021). Based on the teachers' written reflections, key themes were identified and categorized according to Appendix 1.

Ethical approval was sought from their schools to ensure the protection of teachers' rights and confidentiality. Informed consent was obtained from all participants at the beginning of the survey, and teachers could feel free to withdraw from the survey at any time without consequences. Participants' identities were anonymized during the data analysis process.

4. Results

4.1. Teachers' perceptions to adopt GenAI (RQ1)

In this study, it was identified that 35 out of 76 teachers had started to adopt GenAI in teaching/learning, administration, and assessments, and 41 of them had not started using GenAI in education. A total of 48 teachers (63%) claimed that they had received some professional teacher training related to AI before, and learnt the basic concepts of AI. However, only 32 teachers (42.1%) feel confident using AI in the classroom. The overall sentiment analysis conducted by Monkeylearn on

teacher responses, revealing that 57.4% of the feedback was positive.

4.1.1. Perceptions between teachers with and without experience in using GenAI

In the survey, 57 teachers (75%) reported having used AI tools, while 19 teachers (25%) indicated that they have not. This section displays how they perceived GenAI usage differently. The overall sentiment among teachers who have used GenAI is 64% positive, while those who have not used it report a more neutral sentiment of 50.8%. Teachers who have not yet used GenAI tools claimed that they know the opportunities that these technologies could bring to education, such as "enhancing personalized learning experiences", "automating specific tasks" and "enhancing second language learning".

For teachers who haven't used GenAI before, they tend to have more concerns compared with those who have experience in it. Fig. 2 displays the common concerns that are raised by teachers. First, one of the greatest concerns is the lack of technical support and teacher training. A teacher claimed, "I feel unprepared to use GenAI in my classrooms, though I know what AI can do. More teacher training and successful cases are essential so that I can apply GenAI to support teaching in my subject area." Another teacher agreed on this, "I had taken courses to learn what AI is. However, it needs other technical and pedagogical knowledge to enable me to bring AI meaningfully in the classroom." This aligns with another concern raised by teachers that they claimed to be struggling with adapting their teaching methods. A teacher said, "Second, privacy and data security concerns are prevalent, with fears about potential breaches or misuse of student data by service providers. A teacher expressed, "I'm quite worried that I'm not sure if the AI software keeps my data secure." Additionally, concerns about academic dishonesty have emerged, with some educators believing that reliance on AI tools could increase instances of cheating or plagiarism. One teacher stated, "I am concerned this will result in more illegal and dishonest behavior on the part of students." Another teacher said, "I need to check for plagiarism. However, there are grey areas of what 'counts' as plagiarism. I worry about plagiarism. Will we foster a generation of cheaters?" Lastly, there is apprehension that over-reliance on AI might hinder students' critical thinking, creativity, and information literacy skills, as they could become dependent on AI for generating answers rather than developing these essential abilities themselves. A teacher noted, "Students will over-rely on AI and reduce their critical thinking, information literacy, creativity, and problem-solving abilities."

4.1.2. Opportunities of GenAI: teaching/learning, administration and assessments

Regarding the perceived opportunities of using GenAI in education, teachers' qualitative responses were coded according to their feedback in three categories: teaching/learning (P1), administration (P2), and

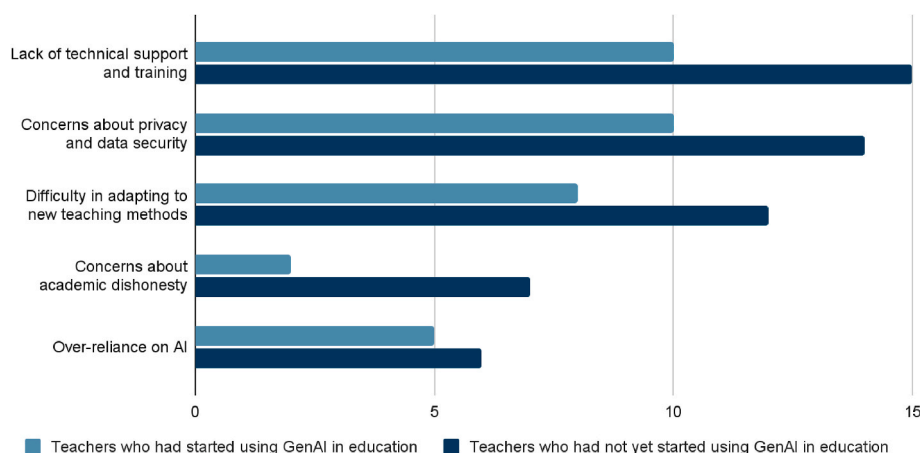


Fig. 2. Concerns raised by educators regarding the use of GenAI in education.

assessment (P3).

Teaching/learning (P1). Teachers have found various opportunities and ways to integrate AI tools into their lesson planning and development. Many educators have mentioned using AI tools to enhance their lesson preparation. A teacher claimed, “ChatGPT and Magic School provide me with a great experience. When I input prompts, GenAI gives me excellent recommendations for lesson planning and preparing teaching materials.” These tools are valuable resources for generating innovative learning tasks, developing rubrics, and tailoring instructional progressions to meet the unique needs of their students. For example, an art teacher stated, “AI tools aid in providing a list of artists for an art movement and supporting the exploration of lesson plan ideas. They also enable students to describe a painting using different art styles.”

Education administration (P2). AI tools also facilitate teachers in their educational administration. Teachers have found ChatGPT particularly helpful in summarizing key points of articles, writing proposals, and generating suggestions for report card comments and reference letters. When asking how GenAI facilitates their everyday work, a teacher said, “GenAI is able to support my teaching evaluation, lesson planning, assessment, report writing, proposal and school notices.” These tools provide valuable assistance in generating ideas, improving writing quality, and serving as a starting point for various written tasks. A teacher also suggested, “AI can help automate administrative tasks and free up their brain power to generate more higher-level and engaging teaching ideas.” Another teacher expressed, “GenAI can streamline many routine tasks such as written communications and notices, organize and summarize data for reports, meeting notes, and documents”. This enables teachers to work more efficiently and frees up time to focus on higher-level and strategic responsibilities. Further, GenAI can assist with analyzing data, identifying trends, and generating insights to inform educational management decisions. Teachers can leverage these capabilities to produce data visualizations, evaluation and reports, and inform strategic planning.

Assessments (P3). GenAI has the potential to facilitate personalized learning assessment. For example, a teacher claimed, “GenAI can provide personalized assessments’ guidance tailored to each student’s needs, prompts and learning progress. With teachers’ inputs, it can automatically generate some feedback content based on students’ strengths and weaknesses”. Another teacher said, “Teachers can use GenAI to generate examination questions and reports according to students’ needs and their prior performance.” Second, GenAI can automate the grading process for certain types of assessments. This saves teachers time by providing quick feedback to students and generating test/examination reports according to students’ performance. A teacher suggested, “The difficulty level and content of assessment questions can be adjusted based on the student’s responses.” This approach ensures that students are challenged appropriately, and their abilities are accurately measured. Another teacher said, “I can provide a rubric to GenAI and ask it to automatically give feedback and recommendations for students’ assessments to facilitate their learning progressions”.

4.1.3. Perceptions between teachers with and without experience in using GenAI

Teachers revealed some subject-specific perceptions of integrating GenAI in their subjects.

English and second language. Language teachers recognized the potential of using GenAI for proofreading, elaborating, refining grammars, consolidating arguments and sentence structures, and enhancing creativity. However, teachers expressed concerns about students misusing these tools. They worried that over-reliance on AI technologies like ChatGPT and Grammarly may hinder the development of students’ writing abilities. A teacher said, “Students might over-rely on these tools for brainstorming and elaborating sentences, which can prevent them from expressing their ideas and constructing sentences throughout their language learning processes”.

Mathematics and science. Although mathematics and science

teachers shared similar concerns about students over-relying on GenAI to generate working steps and solutions, they seem to be more optimistic towards the potential of GenAI to obtain learning feedback. A teacher claimed, “ChatGPT assists students in their mathematical learning by providing guidance and steps that deepen their understanding of the material. When they encounter difficulties, they can seek help from AI.” Another teacher stated, “Students may sometimes resort to copying the steps and answers provided. Still, students can ask AI relevant questions to enhance their understanding and advance their learning.”

Social studies and humanities. Social studies and humanities teachers view GenAI as a valuable tool for enriching discussions, facilitating research, and promoting critical thinking. A teacher noted, “We can encourage students to generate different AI personas and interview GenAI to explore various stakeholders’ viewpoints.” However, these educators express concerns about ethical considerations, particularly regarding the accuracy of AI-generated content and the necessity of verifying information. A teacher said, “Students may become lazy and not do fact checking in their projects.”

Computer science and technology. Computer teachers tend to be more prepared to use GenAI and focused more on developing students’ AI literacy and problem-solving skills. For example, a teacher said, “I consider AI as valuable tools for coding and debugging. It helps make programming more accessible”. At the same time, they recognized the ethical implications of AI, emphasizing the need to educate students about responsible use, data privacy, algorithmic bias, and automation ethics. Additionally, a teacher claimed, “My school was planning for some AI literacy trainings that encourage students’ critical evaluation of AI outputs, and enable them to understand foundational AI concepts and know how to use GenAI responsibly and effectively”.

4.2. Concerns of integrating GenAI into schools (RQ2)

This finding aligns with the socio-ecological model for integrating GenAI in education. This model underscores the importance of strategies that span from meso-level policies to micro-level practices: (1) school’s readiness in terms of policy and management (C1), (2) teachers’ readiness and AI competency (C2), and (3) students’ readiness and AI literacy (C3).

School’s readiness (C1). In terms of school policy and management, teacher training and effective management of AI tools can be challenging. Keeping up with the rapid advancements in AI and ensuring proper utilization of AI tools in the classroom requires ongoing training and support. The absence of clear policies and guidelines regarding the appropriate use of AI in education can create uncertainty and challenges for teachers in implementing AI tools effectively. A teacher claimed, “My main concern is that my school doesn’t seem to be embracing change. There are no AI policies for us to follow.” Another teacher also supported this idea and said, “The lack of well-defined policies and guidelines for the ethical usage of GenAI in education can lead to uncertainty and difficulties for us when implementing GenAI tools.”

Teachers’ readiness and AI competency (C2). Teachers’ readiness could be a great concern. One challenge teachers may face is a lack of professional development programmes and training. Acquiring the necessary skills and knowledge to integrate AI tools into their teaching practices effectively can be difficult without proper support and training. A teacher said, “Teachers may face challenges in acquiring the necessary practical applications and knowledge to integrate AI tools into their teaching practices effectively.” Another teacher noted, “The technical support from the school is insufficient. Teachers may have challenges when using this new technology and choosing appropriate tools.” Additionally, adapting to new teaching methods required for integrating AI can be challenging for educators accustomed to traditional approaches. A teacher claimed, “Integrating AI may require a shift in teaching methodologies, which can be challenging for educators who are accustomed to traditional approaches even if they know what AI is.”

Some teachers may be resistant to adopting AI technologies due to unfamiliarity or reluctance to change established teaching methods. A teacher suggested, “I would like to see further discussions at my school regarding whether teachers should use GenAI in classrooms.” Some teachers suggested advocating for accessible resources for their teaching. A teacher proposed, “Our school could subscribe to licenses for various AI applications, allowing us to evaluate and select the most suitable tools for our students.” Many AI applications require subscription fees, and teachers prefer that schools cover these costs.

Students’ readiness and AI literacy (C3). Even when teachers become ready to adopt GenAI, there are concerns that students’ AI literacy levels may not be sufficient. First, concerns about academic integrity arise with the use of AI tools. This is supported by a teacher, who claimed, “The use of AI tools raises concerns about plagiarism, cheating, and the potential for students to rely solely on AI-generated content without critical thinking or independent learning.” Second, students may not know how to question the accuracy and reliability of information provided by AI systems, particularly in terms of fact-checking and the sources of information. Therefore, promoting AI-related information literacy has become crucial. A teacher said, “Students need to question the accuracy and reliability of learning materials and recommendations provided by AI systems, particularly in terms of fact-checking and the sources of information.” Third, over-reliance on AI can also lead to a decrease in human interaction and social skills among students, which is also a concern for some educators. A teacher reflected, “My concern is that students may use AI without critical evaluation or a clear purpose, which could hinder the development of their critical thinking and analytical skills. It is important to ensure that their skills in critical analysis are properly nurtured and developed.”

4.3. Strategies that encourage teachers to embrace GenAI integration in schools (RQ3)

In teachers’ reflections, they emphasized the significance of several school strategies to support the integration of AI in education: (1) professional development (S1), (2) clear guidelines (S2), (3) accessibility to AI software, and technical support to facilitate teachers to integrate GenAI in education (S3). These factors would empower teachers to leverage the potential of AI and enhance the learning experiences of their students.

Professional development (S1). Teachers expressed a strong desire for professional development opportunities. They recognized the need to acquire more knowledge and skills related to AI and its integration in the classroom. Professional development programs would enable teachers to stay updated with the latest advancements, learn effective strategies for integrating AI, and understand the potential benefits and drawbacks. Teachers also highlighted that they could learn from case studies and examples of successful AI integration in various educational contexts. These examples would serve as inspiration and guidance for teachers, enabling them to adapt and implement similar practices in their classrooms. For example, a teacher wrote, “I would like to learn more about any tools or approaches that can help me ensure that students are completing their work themselves, rather than relying on AI to do it for them.” Teachers also suggested in their reflection: “more professional development opportunities”, and “more use cases to help me facilitate my school document preparation process, assessment creation, and auto marking in my subject discipline”

Clear guidelines (S2). Teachers emphasized the importance of having AI education policies and frameworks that outline the ethical considerations, usage guidelines, and effective practices for integrating GenAI in educational settings. These guidelines would provide teachers with a sense of direction and help them navigate the challenges associated with AI integration. A teacher suggested, “Schools need to revise their assignment and academic integrity policies to incorporate the use of AI, and consider it as a part of the self-regulated learning and reflection process.”

Accessibility to AI software, and technical support (S3). Teachers expressed the need for schools to provide them with access to reliable AI tools and platforms that are specifically designed for educational purposes. Furthermore, having technical support readily available would assist teachers in effectively using AI tools and resolving any technical issues that may arise. Some teachers stated in the survey, “more accessibility of various types of GenAI tools,” and “knowing how to use and having the technical support”.

5. Discussion

This discussion section synthesizes the findings from RQ1 to explore teachers’ perceptions of GenAI usage, revealing insights into their attitudes, concerns, and experiences with this technology in the classroom (5.1). Building on these insights, a socio-ecological model is proposed that fosters meaningful collaboration among stakeholders, including educators, administrators, and policymakers, to ensure a holistic approach to integrating GenAI in school settings (5.2). Practical guidelines are established for creating AI-ready schools, emphasizing the necessary infrastructure and support systems (5.3). To further enrich this discussion, we incorporate a global perspective on government and school policies related to GenAI implementation (5.4). In this section, we adopt a labelling approach to indicate how results in Section 4 support the discussions.

5.1. Teachers’ perceptions of using GenAI in education

According to RQ1, thematic analysis reveals that experienced teachers are generally more optimistic about the benefits of GenAI. In contrast, teachers lacking experience often emphasize apprehensions about the reliability and ethical implications of AI tools. This disparity suggests that familiarity with GenAI greatly influences teachers’ attitudes and concerns. Moreover, the percentage of teachers reporting an understanding of general AI concepts is higher than those who feel confident using AI in the classroom. This indicates a significant awareness-implementation gap between theoretical knowledge and practical application. This emphasizes the need for professional development and training to bridge this gap effectively.

Second, most existing studies have focused on students’ perceptions of how ChatGPT aids in achieving their learning goals and evaluating its benefits (Shoufan, 2023; Vargas-Murillo et al., 2023). In contrast, our study emphasizes teachers’ perceptions, aligning with previous findings that view GenAI as a valuable assistant. Teachers reported that GenAI helps reduce their workload (P2), produce interactive content (P1), and improve the writing quality of their materials (P1). Additionally, it supports teachers in developing innovative learning experiences, conducting evaluations, and designing learning plans, grading rubrics, and quizzes (P1, P3). Furthermore, GenAI can assist educators with tasks such as curriculum development, proposal preparation, and providing immediate feedback to students (P1, P3). It is essential that schools need teacher professional development and evidence to support an informed approach to AI adoption.

Third, most current discussions surrounding GenAI usage in education are not subject-specific; most studies either examined students across various disciplines or did not specify the subject areas at all (Lo et al., 2024). Our findings in Section 4.1.3 helped contribute to the understanding of teachers’ subject-specific perceptions, and aligns with current findings. For example, language teachers can use GenAI tools to enhance students’ writing quality, promote personalized learning, and facilitate their critical thinking through generating coherent and well-structured content. Mathematics teachers can enable students to use GenAI for generating steps and solutions to learn related concepts (Egara & Mosimege, 2024). Science and social science teachers can leverage AI to assist students in conducting inquiries, extracting relevant information from the internet, and summarizing findings (Wu et al., 2024). Further efforts are needed to propose strategies that can be

tailored to different learning contexts and subject disciplines.

According to RQ2, many teachers are aware of potential biases in AI, yet few have concrete strategies to mitigate these risks (C2), highlighting a gap between awareness and action. For instance, educators express concerns that young students may misuse tools like ChatGPT to complete homework without fully understanding the learning material, which could negatively impact their foundational knowledge and cause learning/cognitive laziness (C3). This misuse not only hinders students' development of critical thinking skills but also raises issues of academic integrity and responsible AI usage in education (C3). This aligns with [Mittal et al. \(2024\)](#), who emphasized the challenges of detecting misuse in learning assessments and the necessity for young learners to grasp fundamental concepts rather than simply generating answers using GenAI. However, teachers may lack knowledge of effective safeguarding measures to address these risks (C2). Furthermore, ChatGPT can produce inaccurate information, generate biased content, and lead to academic dishonesty through overreliance on AI-generated responses, which align with existing studies ([Goedde et al., 2023](#); [Lo, 2023](#)). Its limitations in contextual understanding and reasoning can further impede students' development of critical thinking skills ([Wu et al., 2024](#); [Zhang & Tur, 2023](#)). Therefore, it is essential to build strategies tailored to different educational contexts and subjects that enable teachers and students to critically evaluate GenAI content.

Overall, our findings reveal a worrying situation that while teachers are optimistic about AI's potential, they face challenges in fundamental areas such as student privacy, safety and ethical use. Many teachers reported that their schools lack established AI policies and guidelines, and they expressed low confidence of using GenAI in the classroom, and concerns about privacy, critical thinking and learning laziness when it comes to safeguarding students while using AI tools.

5.2. The socio-ecological model

To synthesize RQ2, the socio-ecological model is adopted in this study to help integrate GenAI in education from meso-level policy to micro-level practices ([Singh et al., 2023](#)). This model, is aligned with research like [Aizawa and Rose \(2019\)](#) and [Schoon and Lyons-Amos \(2017\)](#), clarifies the interactions between personal and environmental factors, and is useful for implementing GenAI policies in schools ([O'Dea et al., 2024](#)). The model enhances contextual relevance and empowers stakeholders to influence the use of GenAI in education. Effective implementation necessitates careful planning to ensure that the integration of GenAI is ethical, effective, and responsive to the needs of both students and educators. Although this study does not primarily focus on the macro level, Section 5.4 provides insights into global perspectives on GenAI in education, drawing on national guidelines and policies.

At the meso level, school leaders play a crucial role in this integration. As suggested by RQ2, establishing clear policies, guidelines, and standards is essential for ensuring ethical practices, data privacy, and responsible AI use (C1). Although the findings in this study do not explicitly mention the co-design approach, [Zheng et al. \(2024\)](#) highlighted it as a collaborative strategy that school leaders should promote. This encourages collaboration among universities, AI experts, and other schools to share effective practices and address common challenges of using GenAI. Co-designing approaches can facilitate the meaningful implementation of GenAI into classrooms. Research and development efforts with universities should focus on evaluating the impact of creative AI-empowered instructional models on learning outcomes, and exploring related ethical frameworks (C1). Furthermore, implementing ethical review processes is vital for assessing risks, ensuring compliance, and addressing ethical concerns associated with AI projects. Continuous monitoring and evaluation will be essential for gathering feedback, assessing the effectiveness of GenAI integration, and making necessary adjustments in response to the evolving landscape of AI in education. Finally, financial support is necessary to provide adequate tools, resources, and infrastructure for both teachers and students, especially

since most GenAI tools require subscriptions or licenses.

Moreover, RQ2 focused primarily on students and teachers as the primary end-users of GenAI in learning and teaching. For instance, training is recommended to raise AI literacy and awareness, promoting responsible AI use (C2, C3). However, teachers' discussions have rarely included the involvement of parents. As suggested by [Su et al. \(2023\)](#), parents play a crucial role in understanding school policies and supporting the use of GenAI in their children's learning. Engaging parents in these discussions enables schools to create a supportive environment where they are informed about how AI is utilized in their children's education, allowing them to actively participate in their learning journey. This collaborative approach among educators, students, and parents is essential for fostering a comprehensive understanding of GenAI and its responsible use in educational settings. [Fig. 3](#) displays the proposed AI education policy implementation at the macro, meso and micro levels.

5.3. A proposed guidelines for building an AI-ready school

To reflect on RQ3, inspired by Teach AI Global Initiative Guidance (2024), this study summarized teachers' opinions into a framework to support schools to become AI-ready in three dimensions: create guidance and policies to address school needs, facilitate organizational learning, and promoting improvement and transformation to foster teachers' and student' AI literacy.

Create guidance and policies to address school needs. To address school needs and build teachers' confidence in teaching AI, schools should prioritize the development of GenAI guidance, and policies as suggested by teachers (S2). Given that more students already have access to GenAI applications (e.g., Midjourney, ChatGPT) in their everyday lives, it is important for existing technologies (e.g., learning management systems, search engines, chatbots) to incorporate GenAI functionalities (S3). Guidance should be developed to cover age-appropriate teaching topics, such as basic AI knowledge, the societal impacts of AI, and AI ethics (e.g., plagiarism, bias, and privacy concerns), to meet specific curriculum needs ([Bellas et al., 2023](#)). In addition, schools should incorporate the use of GenAI, and introduce AI-related concepts and skills into the curriculum and in different subject domains ([Bellas et al., 2023](#)). This includes teaching students about the ethical implications of AI, data analysis, and critical thinking across various subjects.

Once the teaching contents have been identified, it is crucial to provide related guidelines and document successful cases for teachers to design their instructional practices in the classroom (S3). It is important to note that teaching GenAI is not limited to computer science lessons; it can involve different subject knowledge. For instance, language teachers could engage students in interacting with GenAI bots to enhance their language acquisition and writing skills. Furthermore, it is essential to ensure that the incorporation of GenAI across curriculum, pedagogy, and technologies aligns with existing ethical, security, and privacy policies. These guidelines should also clarify responsible uses of AI tools, such as human review and maintaining academic integrity. By providing clear guidance and support, schools can empower teachers to effectively integrate AI into their instructional practices while upholding ethical standards and ensuring student safety and privacy.

In addition to guidance, school leaders play a pivotal role in the AI era due to several key reasons. Firstly, they provide a clear vision for organizations in harnessing the power of AI in education. They need to identify the potential of AI to drive schools' major concerns and direction to spur innovation in education and enhance teaching/learning and administration efficiency. They should keep pace with the digital world to identify the transformative impact of AI and articulate a vision that inspires their teaching teams toward an AI-ready goal. Moreover, leaders are responsible for addressing ethical and responsible AI practices. They establish guidelines and policies that ensure AI educational systems are deployed with transparency, fairness, and accountability for parents and students. Leaders have the responsibility to navigate the

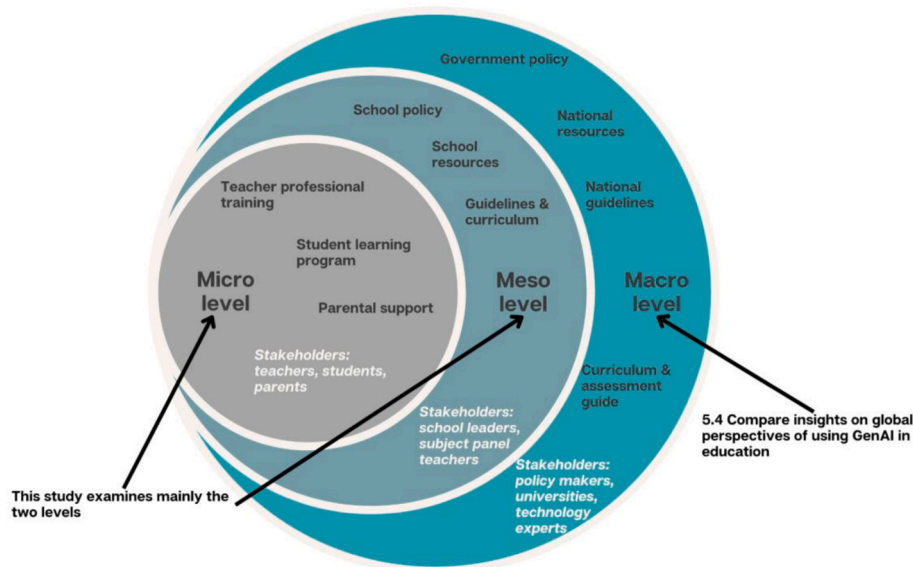


Fig. 3. AI education policy implementation at the macro, meso and micro levels.

ethical complexities of AI, making decisions that prioritize the well-being of students (Crawford et al., 2023). Furthermore, teacher leaders drive collaboration between universities, technical companies, parents, and students in the AI ecosystem. They foster collaborations between academia, industry, and government to exchange best practices, and address shared GenAI teaching and administration challenges. Through collaboration, leaders can leverage collective resources to maximize the potential of AI for the benefit of students.

Facilitate organizational learning. To build teachers' confidence in using AI, schools need to prioritize organizational learning (i.e., teacher professional development) to equip teachers with the knowledge and skills needed to effectively integrate GenAI into their teaching practices (S1). Schools can establish partnerships with organizations and industry experts in the field of AI to provide access to resources, expertise, and opportunities for students to engage in AI-related projects and competitions (Pantanowitz et al., 2022). Further, professional development opportunities should be provided to all teachers, focusing on enhancing their understanding of instructional approaches that effectively integrate GenAI. By bringing together educators' experiences with AI, schools can document successful use cases and identify areas for improvement, building collective organizational knowledge and teacher capacity via lesson planning and teacher sharing. It is important to recognize and address the diverse backgrounds of teachers, ensuring that professional development initiatives are inclusive and considerate of different subject perspectives and teaching contexts when integrating GenAI. This approach will foster a sense of confidence and collaboration among teachers, enabling them to develop meaningful interdisciplinary learning activities.

Promoting teachers' and students' AI literacy. Professional development is crucial for teachers to enhance their understanding of AI technologies and competencies in the classroom (S1). Training programs should focus on practical skills, enabling educators to confidently integrate AI tools into their practices. For example, Ding et al. (2024) found that a case-based AI professional development program in seven middle schools significantly improved teachers' AI literacy. Similarly, Fissore et al. (2024) developed a training program for 53 teachers, emphasizing AI tools and their social impacts. For students, integrating AI literacy into the STEAM learning curricula is also vital; schools should create age-appropriate AI literacy programs that cover fundamental AI concepts and ethical considerations (Ng et al., 2023). Teachers can also engage students in exploring AI's societal impact, enhancing their critical thinking and creativity. Additionally, involving parents through

seminars can help them understand AI's role in education, reinforcing the importance of AI literacy at home and gaining their support in using AI for learning (Ng et al., 2021).

5.4. Comparative insights on global perspectives of GenAI in education

This section enriches the global discourse on GenAI in education by drawing comparisons with existing reports from different countries/regions. By situating the Canadian experience alongside reports and studies from Mainland China, the United States, and Hong Kong. These comparative insights underscore the importance of understanding regional differences in the perspectives of GenAI in school education.

5.4.1. Responses to GenAI in canadian schools

According to the Government of Canada's guide (2024), the integration of GenAI can enhance learning outcomes by supporting personalized learning experiences and fostering creativity in Canadian schools. This guide suggests educators to tailor their approach in using GenAI tools and assist in daily tasks such as drafting documents, generating images in creating presentations, and brainstorming ideas. However, it is crucial to approach the use of these tools with caution, ensuring that risks are appropriately assessed as suggested by the ethical guidelines and privacy regulations outlined in the guide. Teachers should engage with stakeholders, including parents and educational experts, to address potential risks, such as bias in AI-generated content, and to establish best practices that promote critical thinking and digital literacy among students. By combining GenAI with pedagogical strategies, schools can create a more engaging and effective learning environment while maintaining the integrity of educational objectives.

5.4.2. National responses to GenAI in school education

The Chinese government's "Interim Measures for the Management of Generative Artificial Intelligence Services," issued in July 2023, reflects a dual approach of promoting innovation while ensuring national security (Migliorini, 2024). The document employs the term "encouragement" to reflect a proactive stance toward nurturing a culture of school innovation, digital citizenship and lifelong learning. However, it tends to put less focus on student's privacy. For example, some schools would adopt AI-enabled cameras and wearable devices to monitor student behavior and attendance in real-time. In contrast, Canada recognized the importance of privacy and cybersecurity in its AI initiatives, and they could not track student engagement during lessons (Attard-Frost et al.,

2024). Furthermore, in February 2024, China's Ministry of Education announced a list of 184 primary and secondary schools designated as AI education bases to strengthen the development of AI education (The State Council The People's Republic of China, 2024). This top-down approach equips schools to develop AI-based curricula, integrate disciplines, reform teaching methods, collaboratively construct and share AI education resources, and enhance teachers' AI literacy. In contrast, Canada's efforts are more decentralized and use bottom-up initiatives rather than a cohesive national strategy for integrating AI into the curriculum.

In the USA, the report "Artificial Intelligence and the Future of Teaching and Learning: Insights and Recommendations" (United States Office of Educational Technology, 2023) outlines strategies for effectively leveraging these technologies within the education sector. With a highly developed ed-tech market, the USA has established guidelines and resources aimed at a broad audience, including teachers, educational leaders, policymakers, researchers, and innovators in educational technology. Schools have the flexibility to design their own policies according to their specific needs. Some forward-thinking schools are adopting advanced GenAI applications; however, the absence of a top-down approach means that schools are not mandated to follow specific policies or implement AI, creating a gap between those willing to advance and those that are not. In October 2023, across 51 states, less than half of the states ($n = 23$) had released some form of AI guidance. In contrast, Canada is less technologically prepared than the USA and tends to adopt a school-based bottom-up approach rather than a top-down strategy. While there are initiatives and growing interest in AI's potential, Canada's approach is generally less developed, lacking the necessary resources and strategies to support widespread adoption across K-12 education.

5.4.3. Responses to GenAI in school education in Canada and Hong Kong

In light of the contributions from authors based in Canada and Hong Kong, this section discusses the similarities and differences between the two places in their perceptions of GenAI in education. Although there is currently no research evidence quantifying the percentage of students using GenAI for their learning or schoolwork, some findings indicate that both educators and students recognize the potential of GenAI to enhance learning outcomes (e.g., HKEDB, 2024). However, they also face similar ethical dilemmas: students must navigate the risks of academic dishonesty while striving to keep up with rapid technological advancements. However, Canada and Hong Kong differ in their regulatory approaches to GenAI in education. In Canada, the lack of clear guidelines leaves students, parents, and teachers to navigate a bottom-up approach to GenAI integration in education.

In contrast, Hong Kong has taken proactive steps by implementing structured frameworks and official AI curricula that promote responsible AI use in classrooms (HKEDB, 2024). Such proactive measures could mitigate concerns related to academic integrity and ensure that AI serves as a supportive educational tool rather than a shortcut for learning. Despite these differences, both places share concerns about the impact of GenAI on critical thinking and knowledge retention. For example, in Canada, it is worried that GenAI could exacerbate digital divide, misinformation, privacy violations, and reduced students' critical thinking due to over-reliance on AI. Similarly, educators in Hong Kong voice apprehension about students becoming overly reliant on technology at the expense of foundational skills. HKEDB (2024) highlighted the importance of equipping teachers with the abilities to guide students in using ChatGPT effectively. This includes instructing students on effective prompting techniques to retrieve accurate information. To ensure responsible use, schools should establish clear guidelines outlining acceptable contexts for using ChatGPT. Students proposed the use of monitoring software that prevents the misuse of ChatGPT on their electronic devices. In contrast, Hong Kong has established region-level plans to introduce AI education systematically across schools. This proactive approach contrasts with Canada's reliance on local and civil

society initiatives to promote AI literacy. Such a divergence highlights the differences in educational frameworks and governance systems between the two regions, with Hong Kong adopting a more centralized strategy for integrating AI into the curriculum.

Overall, there is a growing divide between Canadian schools and those in other countries/regions, where many institutions from other countries/regions are beginning to implement safeguards, understand bias risks, and establish clear educational goals for AI use through top-down and diversified approaches. In contrast, Canadian schools tend to adopt a bottom-up approach, accumulating evidence to support AI adoption. This disparity contributes to a new digital divide in education across countries/regions. Teachers in Canada are also noticing that students increasingly use AI at home, often without proper guidance or oversight, resulting in differences in support for students navigating these tools safely, like other countries/regions. Like other countries/regions, teachers in Canada are also noticing that students increasingly use AI at home, often without proper guidance or oversight, resulting in differences in support for students navigating these tools safely. This study highlights the urgent need to equip educators with comprehensive training in strategies to deal with AI safety and ethics, and practical application. Schools need to develop robust AI training programs to enhance both teacher and student AI literacy.

6. Conclusion and limitations

Although some studies have started to explore the impact of GenAI on practices and policies in education through case studies (e.g., Chiu, 2023; Cooper, 2023; O'Dea & O'Dea, 2023), much research is needed to examine how teachers adopt GenAI, how they perceive the technologies, and what can encourage their use via a whole school approach. To address this gap, in this study, Canadian teachers showed a positive perception and are aware of opportunities for integrating GenAI in teaching, learning, and administration. However, several challenges and concerns were identified that need to be addressed for successful implementation. Teachers' readiness is highlighted in this study, striving for the importance of providing professional development opportunities to enhance teachers' knowledge and skills related to GenAI. Moreover, clear school policies and guidelines were also seen as essential to ensure the responsible and ethical use of AI in educational settings. Access to AI software and technical support provided by their schools were identified as key factors that would facilitate teachers in integrating GenAI effectively into their classrooms. By prioritizing professional development, establishing clear guidelines, and ensuring access to AI software and technical support, schools can foster a culture that embraces AI and maximizes its benefits in educational contexts.

However, there are limitations in this study. Firstly, the sample consisted of teachers who participated in a conference, indicating a potential bias towards those who already had an intention to learn about AI. It would be beneficial to collect feedback from a broader range of teachers, including those who may have more reservations or negative perceptions towards AI integration. Secondly, this study was preliminary and did not involve any specific interventions to examine teachers' pre- and post-perceptions. To gain a more comprehensive understanding of teachers' perspectives on GenAI integration, future research should focus on developing and adapting questionnaires that address the unique situations and challenges related to AI in education.

CRedit authorship contribution statement

Davy Tsz Kit Ng: Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Eagle Kai Chi Chan:** Writing – review & editing, Resources, Investigation, Data curation. **Chung Kwan Lo:** Writing – review & editing, Resources, Data curation.

Statements on open data

Data available on request from the authors.

Ethics and conflicts of interest

The authors declare that they have no conflict of interest. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The research has gain approval from institutional ethics committee. Informed consent was obtained from all individual participants included in the study.

Declaration of generative AI in scientific writing

During the preparation of this work the author(s) used POE in order to paraphrase elements of texts, elaborate sentences and proofread for helping me to stimulate thinking and clarify language and accuracy. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Funding and acknowledgements

This work described in this paper was supported by Department of Mathematics and Information Technology (Department Research Grant; MIT/DRG02/24-25), The Education University of Hong Kong.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.caeai.2025.100373>.

References

- Aizawa, I., & Rose, H. (2019). An analysis of Japan's English as medium of instruction initiatives within higher education: The gap between meso-level policy and micro-level practice. *Higher Education*, 77(6), 1125–1142.
- Attard-Frost, B., Brandusescu, A., & Lyons, K. (2024). The governance of artificial intelligence in Canada: Findings and opportunities from a review of 84 AI governance initiatives. *Government Information Quarterly*, 41(2), Article 101929.
- Bellas, F., Guerreiro-Santalla, S., Naya, M., & Duro, R. J. (2023). AI curriculum for European high schools: An embedded intelligence approach. *International Journal of Artificial Intelligence in Education*, 33(2), 399–426.
- Borah, A. R., Nischith, T. N., & Gupta, S. (2024). Improved learning based on GenAI. In *2024 2nd international conference on intelligent data communication technologies and internet of things (IDCIoT)* (pp. 1527–1532). IEEE.
- Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, 20(1), 43.
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, 8, 75264–75278.
- Chiu, T. K. (2023). The impact of generative AI (GenAI) on practices, policies and research direction in education: A case of ChatGPT and Midjourney. *Interactive Learning Environments*, 1–17.
- 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.
- Crawford, J., Cowling, M., & Allen, K. A. (2023). Leadership is needed for ethical ChatGPT: Character, assessment, and learning using artificial intelligence (AI). *Journal of University Teaching and Learning Practice*, 20(3), 2.
- Ding, A. C. E., Shi, L., Yang, H., & Choi, I. (2024). Enhancing teacher AI literacy and integration through different types of cases in teacher professional development. *Computers and Education Open*, 6, Article 100178.
- Egara, F. O., & Mosimege, M. (2024). Exploring the integration of artificial intelligence-based ChatGPT into mathematics instruction: Perceptions, challenges, and implications for educators. *Education Sciences*, 14(7), 742.
- Fissore, C., Floris, F., Conte, M. M., & Sacchet, M. (2024). Teacher training on artificial intelligence in education. In *Smart learning environments in the post pandemic era: Selected papers from the CELDA 2022 conference* (pp. 227–244). Cham: Springer Nature Switzerland.
- Gayed, J. M., Carlon, M. K. J., Oriola, A. M., & Cross, J. S. (2022). Exploring an AI-based writing Assistant's impact on English language learners. *Computers in Education: Artificial Intelligence*, 3, Article 100055.
- Goedde, D., Noehl, S., Wolf, C., Rupert, Y., Rimkus, L., Ehlers, J., ... Sellmann, T. (2023). A SWOT (strengths, weaknesses, opportunities, and threats) analysis of ChatGPT in the medical literature: Concise review. *Journal of Medical Internet Research*, 25, Article e49368.
- Herbold, S., Hautli-Janisz, A., Heuer, U., Kikteva, Z., & Trautsch, A. (2023). A large-scale comparison of human-written versus ChatGPT-generated essays. *Scientific Reports*, 13(1), Article 18617.
- HKEDB. (2024). Module on artificial intelligence for junior secondary level. Retrieved from <https://www.edb.gov.hk/en/curriculum-development/kla/technology-edu/resources/InnovationAndTechnologyEducation/resources.html>.
- Jaboob, M., Hazameh, M., & Al-Ansi, A. M. (2024). Integration of generative AI techniques and applications in student behavior and cognitive achievement in Arab higher education. *International Journal of Human-Computer Interaction*, 1–14.
- Jansen, B. J., Jung, S. G., & Salminen, J. (2023). Employing large language models in survey research. *Natural Language Processing Journal*, 4, Article 100020.
- Knight, S., Dickson-Deane, C., Heggart, K., Kitto, K., Kozanoglu, D. C., Maher, D., ... Zarabi, F. (2023). Generative AI in the Australian education system: An open data set of stakeholder recommendations and emerging analysis from a public inquiry. *Australasian Journal of Educational Technology*, 39(5), 101–124.
- Kohnke, L., Moorhouse, B. L., & Zou, D. (2023). Exploring generative artificial intelligence preparedness among university language instructors: A case study. *Computers in Education: Artificial Intelligence*, 5, Article 100156.
- Kong, S. C., Cheung, M. Y. W., & Tsang, O. (2024). Developing an artificial intelligence literacy framework: Evaluation of a literacy course for senior secondary students using a project-based learning approach. *Computers in Education: Artificial Intelligence*, 6, Article 100214.
- Laviola, F., Palese, B., Kim, S. T., & Cucari, N. (2024). are Created Equal: The Case of a Soft Skills Coaching Bot in Education. In *Vol. 2024. Academy of Management Proceedings* (p. 18543). Valhalla, NY: Not all AI Chatbots. No. 1.
- Levin, G., Horeh, N., Brezinov, Y., & Meyer, R. (2024). Performance of ChatGPT in medical examinations: A systematic review and a meta-analysis. *BJOG: An International Journal of Obstetrics and Gynaecology*, 131(3), 378–380.
- Lo, C. K. (2023). What is the impact of ChatGPT on education? A rapid review of the literature. *Education Sciences*, 13(4), 410.
- Lo, C. K., Yu, P. L. H., Xu, S., Ng, D. T. K., & Jong, M. S. Y. (2024). Exploring the application of ChatGPT in ESL/EFL education and related research issues: a systematic review of empirical studies. *Smart Learning Environments*, 11(1), 50.
- Migliorini, S. (2024). China's Interim Measures on generative AI: Origin, content and significance. *Computer Law & Security Report*, 53, Article 105985.
- Mittal, U., Sai, S., & Chamola, V. (2024). A comprehensive review on generative ai for education. *IEEE Access*.
- Moorhouse, B. L., & Kohnke, L. (2024). The effects of generative AI on initial language teacher education: The perceptions of teacher educators. *System*, 122, Article 103290.
- Moundridou, M., Matzakos, N., & Doukakos, S. (2024). Generative AI tools as educators' assistants: Designing and implementing inquiry-based lesson plans. *Computers in Education: Artificial Intelligence*, 7, Article 100277.
- Ng, D. T. K., Leung, J. K. L., Chu, S. K. W., & Qiao, M. S. (2021). Conceptualizing AI literacy: An exploratory review. *Comp. Educ. Artif. Intell.*, 2, 100041.
- Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educ. Technol. Res. Dev.*, 71(1), 137–161.
- Ng, D. T. K., Tan, C. W., & Leung, J. K. L. (2024). Empowering student self-regulated learning and science education through ChatGPT: A pioneering pilot study. *British Journal of Educational Technology*.
- O'Dea, X. C., & O'Dea, M. (2023). Is artificial intelligence really the next big thing in learning and teaching in higher education? A conceptual paper. *Journal of University Teaching and Learning Practice*, 20(5).
- O'Dea, X., Ng, D. T. K., O'Dea, M., & Shkuratsky, V. (2024). Factors affecting university students' generative AI literacy: Evidence and evaluation in the UK and Hong Kong contexts. *Policy Futures in Education*, Article 14782103241287401.
- Pantanowitz, L., Bui, M. M., Chauhan, C., ElGabry, E., Hassell, L., Li, Z., ... Becich, M. J. (2022). Rules of engagement: Promoting academic-industry partnership in the era of digital pathology and artificial intelligence. *Academic Pathology*, 9(1), Article 100026.
- Roth, M. A., & Price, J. K. (2016). The critical role of leadership for education transformation with successful technology implementation. *ICT in education in global context: Comparative reports of innovations in K-12 education*.
- Rudolph, J., Ismail, F. M. M., & Popenici, S. (2024). Higher education's generative artificial intelligence paradox: The meaning of chatbot mania. *Journal of University Teaching and Learning Practice*, 21(6).
- Ryazanov, I., Ohman, C., & Björklund, J. (2025). How ChatGPT changed the media's narratives on AI: A semi-automated narrative analysis through frame semantics. *Minds and Machines*, 35(1), 1–24.
- Sadriu, S., Nuci, K. P., Imran, A. S., Uddin, I., & Sajjad, M. (2021). An automated approach for analysing students feedback using sentiment analysis techniques. In *Mediterranean conference on pattern recognition and artificial intelligence* (pp. 228–239). Cham: Springer International Publishing.
- Samala, A. D., Rawas, S., Wang, T., Reed, J. M., Kim, J., Howard, N. J., & Ertz, M. (2024). Unveiling the landscape of generative artificial intelligence in education: A comprehensive taxonomy of applications, challenges, and future prospects. *Education and Information Technologies*, 1–40.
- Schoon, I., & Lyons-Amos, M. (2017). A socio-ecological model of agency: The role of psycho-social and socioeconomic resources in shaping education and employment transitions in England. *Longitudinal and Life Course Studies*, 8(1), 35–56.

- Shoufan, A. (2023). Exploring students' perceptions of ChatGPT: Thematic analysis and follow-up survey. *IEEE Access*, 11, 38805–38818.
- Siemens, G., Marmolejo-Ramos, F., Gabriel, F., Medeiros, K., Marrone, R., Joksimovic, S., & de Laat, M. (2022). Human and artificial cognition. *Computers in Education: Artificial Intelligence*, 3, Article 100107.
- Singh, V., Bilal, D., Cox, A., Chidziwisano, G. H., & Dinneen, J. D. (2023). Global AI initiatives: From theory to practice. *Proceedings of the Association for Information Science and Technology*, 60(1), 836–840.
- Tracy, S. J. (2024). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. John Wiley & Sons.
- United States Office of Educational Technology. (2023). Artificial intelligence and the future of teaching and learning: Insights and recommendations. Retrieved from <https://digital.library.unt.edu/ark:/67531/metadc2114121/>.
- Vargas-Murillo, A. R., de la Asuncion, I. N. M., & de Jesús Guevara-Soto, F. (2023). Challenges and opportunities of AI-assisted learning: A systematic literature review on the impact of ChatGPT usage in higher education. *International Journal of Learning, Teaching and Educational Research*, 22(7), 122–135.
- Wang, Y. (2021). When artificial intelligence meets educational leaders' data-informed decision-making: A cautionary tale. *Studies In Educational Evaluation*, 69, Article 100872.
- Watkins, M. W., & Pacheco, M. (2000). Interobserver agreement in behavioral research: Importance and calculation. *Journal of Behavioral Education*, 10, 205–212.
- Wu, D., Chen, M., Chen, X., & Liu, X. (2024). Analyzing K-12 AI education: A large language model study of classroom instruction on learning theories, pedagogy, tools, and AI literacy. *Computers in Education: Artificial Intelligence*, 7, Article 100295.
- Yan, L., Sha, L., Zhao, L., Li, Y., Martinez-Maldonado, R., Chen, G., ... Gašević, D. (2024). Practical and ethical challenges of large language models in education: A systematic scoping review. *British Journal of Educational Technology*, 55(1), 90–112.
- Yang, W. (2022). Artificial Intelligence education for young children: Why, what, and how in curriculum design and implementation. *Computers in Education: Artificial Intelligence*, 3, Article 100061.
- Yang, X., Wang, Q., & Lyu, J. (2024). Assessing ChatGPT's educational capabilities and application potential. *ECNU Review of Education*, 7(3), 699–713.
- Yue, M., Jong, M. S. Y., & Ng, D. T. K. (2024). Understanding K-12 teachers' technological pedagogical content knowledge readiness and attitudes toward artificial intelligence education. *Education and Information Technologies*, 1–32.
- Zhang, P., & Tur, G. (2024). A systematic review of ChatGPT use in K-12 education. *European Journal of Education*, 59(2), Article e12599.
- Zheng, C., Yuan, K., Guo, B., Hadi Mogavi, R., Peng, Z., Ma, S., & Ma, X. (2024). Charting the future of AI in project-based learning: A Co-design exploration with students. In *Proceedings of the CHI conference on human factors in computing systems* (pp. 1–19).
- UNESCO. (2023). Guidance for generative AI in education and research. Retrieved from <https://www.unesco.org/en/articles/guidance-generative-ai-education-and-research>.