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Generative Artificial Intelligence in Secondary Education: Learning Support, Challenges, and Educational Equity

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Abstract. Generative artificial intelligence (AI) is entering the field of secondary education through dialogue systems, content generation tools, and AI-supported learning platforms. Therefore, this paper reviews the application of Generative AI in teaching and learning, the associated risks, and the conditions for schools to achieve fair and responsible integration. In particular, it synthesizes peer-reviewed research in areas such as large language models, personalized school teaching, conversational teaching, assessment, academic integrity, and educational inequality, and combines international and Chinese policy guidance. Existing evidence shows that Generative AI can provide differentiated explanations, rapid feedback, various forms of learning resources, and support for curriculum preparation and assessment design. However, these benefits depend on how Generative AI is used. Errors and bias in AI output, privacy risks, academic misconduct, overreliance on AI, uneven teacher preparation, and unequal access to resources can weaken learning outcomes or widen existing gaps. On this basis, the findings support a teaching-first, people-centered approach. Teachers should retain professional judgment, while students should verify and critically assess AI outputs. Assessments should consider both learning processes and outcomes, and schools should provide safe tools and targeted support. In this context, fairness means more than access to AI tools, and students also need meaningful opportunities to develop AI literacy and use Generative AI for learning.

Keywords: Generative AI, Secondary Education, Personalized Learning, Educational Equity, AI Literacy

1. Introduction

Generative artificial intelligence (AI) refers to systems that generate new text, images, audio, video, code, and other content in response to prompts. In particular, large language models are particularly important in the field of education because teachers and students can use natural language to seek explanations, examples, questions, summaries, and feedback without requiring programming skills. Due to the wide use of these models, AI has no longer been confined to administrative management and research tasks, but has also begun to affect teaching, homework, assessment and daily decision-making in schools [1, 2]. In education, its use may provide personalized support, content creation, feedback, and higher student engagement, but may also lead to issues such as false information, bias, privacy leakage, cheating, and excessive reliance on AI-generated answers [1, 3, 4]. For

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instance, a survey of university students in Hong Kong found that students valued these benefits but remained concerned about accuracy, privacy, ethics, and personal development [5]. However, such evidence may not fully apply to secondary education, where students' knowledge, judgment, self-control, and study habits are still developing, making teacher and school support more important [2]. Moreover, schools and families vary in access to equipment, internet, paid AI tools, quiet study spaces, and adult support. Therefore, Generative AI may expand access to learning support while also widening educational gaps. Based on this, using the narrative literature review method, this paper investigates the application of generative AI in junior high school teaching and learning, as well as the risks of teaching and learning, as well as issues related to school fairness and responsible use. In particular, the review mainly uses peer-reviewed studies, along with international guidelines and two Chinese policy documents addressing age limits, privacy, appropriate use, and fair access. Moreover, studies from primary and higher education are included only when relevant to mechanisms or governance, with their differences from junior high school education noted.

2. Overview of generative artificial intelligence in secondary education

2.1. Basic foundations and features of generative artificial intelligence

Generative AI is different from traditional search engines or fixed educational programs. It does not directly retrieve stored answers but generates probabilistic responses based on the patterns learned during the training process. Meanwhile, it can continue conversations, adjust language and format, and quickly create multiple versions of content. These features make it flexible, but they also mean that smooth output may not be accurate, up to date, or unbiased, and may not come from a traceable source [1, 2]. For this reason, educational responses should be treated as drafts or contributions to a conversation rather than verified knowledge.

The output of these tools is also shaped by prompts and context. As a result, two students may receive different results because they understand the task differently, provide different background information, or use different systems. Thus, the effective use of generative artificial intelligence not only requires operational skills but also requires understanding the limitations of the tool, evaluating information and evidence, protecting personal data, and determining when professional help is needed. In this view, AI literacy includes technical knowledge, critical judgment, ethical awareness, and purposeful use [6]. For middle school students, these abilities are particularly important because generative and conversational interfaces may make the answers seem authoritative and personalized, while unstable outputs require students to evaluate and self-regulate, and these abilities are still in the process of development [2, 6]. Therefore, the features that make large language models easy to use also increase the necessity of guiding students to conduct verification.

2.2. Educational context and transformation of learning environments

Generative AI can change the learning environment by providing ongoing support via conversation. For example, students can request for simpler explanations, more examples, practice exercises or comparisons between different viewpoints; teachers can prepare draft materials in advance, adjust the difficulty of tasks, or anticipate possible misunderstandings. These developments have also raised questions about how artificial intelligence should be designed and used. Research indicates that generative artificial intelligence is influencing educational practices, institutional policies, and research priorities, while school-based reviews emphasize that teacher training and teaching goals remain central [7, 8].

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Roles may also change. Teachers no longer merely serve as disseminators of information, but become designers and evaluators who support the activities of artificial intelligence; while students are expected to raise questions, make comparisons, modify and argue, rather than merely receiving the output results. In an action research project conducted in a high school in Western Australia, four teachers regarded generative artificial intelligence as a conversational participant rather than an authoritative answer provider [9]. Students expanded, verified, contextualized and clarified their ideas through subsequent questions. Though this study did not prove a wide causal effect, it showed how pedagogy can influence the quality of students' interaction with AI. These interactions have changed the organization of the secondary classroom in several ways. Support is no longer limited by teacher availability, students can receive different explanations at the same time, and the boundaries between writing, feedback, and revision are less clear. This also makes students' learning processes harder to observe. If teachers cannot see students' prompts, drafts, and revisions, it may be harder to understand how their work develops. Thus, Generative AI changes how students find information and how classroom activities are managed and monitored. However, these changes do not necessarily indicate improved academic performance, as school-based longitudinal studies remain limited [8, 9].

3. Learning support and applications of generative artificial intelligence

3.1. Personalized learning and differentiated support

One frequently proposed benefit is the ability to adjust explanations and materials to differences in prior knowledge, language proficiency, pace, or interest. For instance, a teacher can use these tools to create examples at different levels, make instructions clearer, or provide extra practice to address common misunderstandings. Students can also request clarification without waiting for the next lesson. This kind of support may be particularly useful in mixed-ability classrooms, provided that curriculum goals and teacher review guide the generated material [1, 8]. However, school-based evidence remains developing. For example, a study of 110 pupils aged 8-14 in grades four to six at two Uruguayan schools used Generative AI to adjust lesson materials to students' knowledge levels [10]. As the study focused mainly on primary education, it supports the use of curriculum-based adaptation but does not directly show its effects in secondary schools. In contrast, evidence from high school suggests that adaptive support may not always boost learning. In a quasi-experimental study of 153 high-school programming students, those who used ChatGPT reported lower flow, self-efficacy, and learning achievement than those using conventional methods [11]. Interviews after the study suggested that the tool did not meet students' needs for help with complex programming tasks. These studies reveal that personalization relies on the task, the quality of guidance, and whether AI support helps students reason rather than replaces their own thinking.

3.2. Learning processes and student engagement

Conversational interaction can increase opportunities for practice and formative feedback. Students may rehearse a language dialogue, test an explanation, generate counterarguments, or request hints before seeing a solution. The immediate feedback can reduce the delay between asking a question and receiving an answer, which may encourage hesitant students to express themselves openly. However, quick reviews show that the effects vary across different disciplines and learning designs; using tools does not equate to understanding the concepts [3].

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Indeed, a productive model is to use Generative AI as a partner in inquiry. Students can compare an AI explanation with a textbook, identify unsupported claims, improve a weak argument, or ask the model to present competing interpretations. In a secondary-school project, follow-up questions showed active engagement and provided chances for critical and creative thinking [9]. Importantly, the important mechanism was not simply access to generated answers, but a structured dialogue that required students to interrogate them. Teachers should therefore design prompts and follow-up tasks that make reasoning visible, such as source checking, explanation in the student's own words, or reflection on how an answer changed.

3.3. Teaching practices and educational assessment

For teachers, generative artificial intelligence can assist in completing daily draft work, like course outlines, examples, tests, grading criteria, differentiated practice questions, and possible feedback. In addition, it can also suggest alternative explanations or convert one resource into several formats. These functions may create time for responsive teaching, but outputs require professional checking for factual accuracy, curriculum alignment, language level, cultural assumptions, and accessibility. Generative AI should support teacher judgment, not replace it [7, 8].

However, assessment requires more substantial redesign. If a conventional take-home task can be completed by entering the prompt into an AI system, the task may no longer reveal the student's level of knowledge. Rather than focusing only on detection or prohibition, teachers can use drafts, oral explanations, in-class tasks, annotated sources, process logs, and reflections on AI use. They can also design tasks that require local evidence, comparison, evaluation, or application to a new situation. Research on academic integrity has focused mainly on higher education, so its findings need to be adapted for adolescents. Even so, the main principle remains: assessment should make authorship and learning processes more visible, while rules should clearly distinguish acceptable support from substitution [12].

4. Challenges and equity issues of generative AI in secondary education

4.1. Trust and ethical concerns in generative AI use

The first challenge is epistemic trust. For example, a large language model can produce a confident explanation, quotation, or reference that is incomplete or false. This can be especially difficult for students with limited subject knowledge, who may be less able to detect such errors. Moreover, bias in training data can also reproduce stereotypes or marginalize less represented languages, cultures, and perspectives. For this reason, apparent fluency should not replace evidence, and high-stakes educational decisions should not depend on unverified model output [1, 4]. Another concern is privacy. For example, prompts may contain names, school records, learning difficulties, or sensitive personal experiences. In response, international guidance recommends data protection, ethical checks, and age-appropriate limits for independent use of Generative AI. Then schools must determine which tools are approved, what data must never be entered, how generated content is stored, and who is accountable when errors occur. These responsibilities cannot be transferred to individual students through a general warning. Safe use requires procurement review, clear procedures, teacher supervision, and accessible reporting when harmful or inappropriate output appears.

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4.2. Impacts on learning and teaching processes

The main teaching risk is cognitive offloading. In practice, students may ask the model to do the very tasks they are supposed to learn. When Generative AI formulates arguments, selects evidence, resolves intermediate steps, or generates the final answer, learners may submit a polished product without undergoing retrieval, planning, problem-solving, writing, or revision exercises. This is not merely a matter of frequency of use; it is a mismatch between the tool's functionality and the expected learning process. The auxiliary system may provide scaffolding when providing prompts, counterexamples, or questions; however, when it erases the reasoning process that should have been cultivated through practice, it becomes a substitute for thinking [1, 9]. Since teachers see the results rather than the delegated reasoning process, over-reliance may lead to a capability illusion and make it more difficult to identify incorrect ideas.

This loss of process also weakens assessment validity. When the amount and type of AI help are unknown, a mark may not reliably show a student's knowledge. Meanwhile, unreliable AI detection and judgment may misclassify legitimate work, thus leading to unfair accusations [12]. For teachers, the same opacity generates additional work: they must inspect outputs, distinguish support from substitution, redesign tasks, document rules, and respond to disputes. However, a systematic review of 197 K-12 studies identifies opportunities in personalization, motivation, and assessment, but also reports continuing needs for teacher preparation, ethical guidance, privacy protection, and more concrete classroom research [8]. Therefore, the risk is not merely that Generative AI adds another classroom tool, but that it changes the evidence on which teachers judge learning while expanding the professional labor required to interpret that evidence.

4.3. Unequal access to AI-supported learning opportunities

Educational equity concerns both access and the ability to benefit. Students differ in device quality, connectivity, quiet study space, language, disability access, parental support, and access to paid models. Similarly, schools differ in infrastructure, technical support, staff expertise, and budgets. As a result, if advanced AI support is mainly available to already advantaged learners, personalized learning may become personalized advantage. Besides, Generative AI may help bridge educational divides while also creating challenges involving infrastructure, skills, bias, and inclusion [13]. Thus, equity should be assessed by access and outcomes, not simply by tool availability.

Differences in AI literacy deepen this divide. For example, a learner who knows how to provide context, request revision, verify sources, and recognize limitations will receive more educational value than a learner who accepts the first response. Unequal teacher guidance can produce the same pattern between classrooms. On the contrary, well-designed Generative AI can expand access in situations where professional support is limited by providing alternative explanations, translations, accessible formats or supplementary resources. The 2025 Guidelines of China clearly state that generative artificial intelligence is closely related to personalized learning, accessibility services, resource support in remote areas, and the prevention of the emergence of new digital divides [14]. It also differentiates use by school stage, emphasizing more restricted and supervised use for younger pupils and progressively more analytical or exploratory use in secondary education. This approach shows that equity includes protection as well as provision.

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5. Strategies and future directions for responsible and equitable use

5.1. AI literacy and teacher training for effective AI use

Students need clear AI literacy rather than informal exposure. This includes how generative models produce outputs, why errors and biases occur, how to verify information, how to protect privacy, when to disclose the use of AI assistance, and when not to use AI. These skills should be practiced in various subjects. For example, a history class might verify competing accounts; a science class might inspect assumptions in an explanation; a language class might compare drafts and justify revisions. Similarly, China's general AI education guidance organizes learning progressively across knowledge, skills, thinking, and values, including critical awareness and ethical responsibility [6].

Teachers need corresponding professional development that combines technical familiarity with pedagogy, assessment, ethics, and inclusion. However, short tool demonstrations are insufficient. Instead, collaborative lesson design, classroom trials, shared evaluation criteria, and discussion of unsuccessful examples can help teachers make evidence-informed decisions. Furthermore, training should also protect teacher agency: educators must be able to reject an AI-supported activity when it does not serve a clear learning purpose [7, 8].

5.2. AI-supported teaching design and learning practices

Integration should begin with a learning objective, not with the novelty of a tool. To guide this process, teachers should first identify the knowledge or skills students need to develop, the thinking that should remain with the learner, the limited functions that Generative AI can perform, and the evidence that can show whether learning has occurred. Based on these considerations, a pedagogy-first design may position AI as an example generator, questioning partner, feedback source, or object of critique. It should rarely position AI as the final authority.

In the classroom, classroom routines can put this approach into practice. As a practical synthesis developed in this review, rather than a validated framework taken from a single study, this paper proposes a "predict-prompt-verify-revise" routine. Students first make an initial prediction, then consult the tool, verify its claims against reliable sources, and revise their work with an explanation. Group dialogue can expose differences between prompts and outputs, reducing the impression that one generated response is definitive. The routine is informed by evidence that dialogic design can encourage elaboration and verification, and that AI-generated materials are more defensible when they remain tied to teacher-selected curriculum goals [9, 10]. It should be treated as a proposed classroom approach for testing and refinement, not as an established model.

5.3. Ethical guidelines and equal access to AI resources

Unequal access, varying AI literacy, and differences in school capacity can create different forms of disadvantage. Accordingly, responses should match each source. For instance, where equipment or internet access is uneven, schools can provide approved tools, shared devices, and supervised access during school hours instead of requiring students to complete AI-based assignments. Similarly, when students have differences in their ability to follow prompts and verify information, explicit AI literacy education is needed, and teachers should demonstrate it. For students facing language or disability barriers, the platform and tasks should offer accessible interfaces, alternative formats, and human support; the generated translations or auxiliary measures still need to ensure accuracy. In all

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cases, when learners are unable to safely or effectively use the system, non-artificial intelligence approaches should be retained.

At the system level, differences in school capacity require broader support rather than expecting each teacher to solve the problem alone. For example, resource-limited schools may need public or centrally licensed platforms, shared lesson banks, technical support, and targeted teacher training. Meanwhile, privacy and safety gaps can be addressed via approved-system lists, rules on prohibited data, age-appropriate supervision, clear disclosure rules, and review procedures [2]. In this context, China's guidance combines staged access with learning support, safety, and equity, providing a policy basis for these measures [14]. Evaluation should compare participation, support quality, and learning outcomes across socioeconomic, regional, language, and disability groups [13]. If benefits remain concentrated among students who already have strong digital resources and adult guidance, access has not become equitable and the implementation should be revised.

6. Conclusion

The study suggests that Generative AI has genuine but conditional educational value in secondary education. It can support differentiated explanations, rapid feedback, inquiry, material design, and assessment planning. However, these benefits depend on curriculum alignment, teacher mediation, student effort, reliable verification, and learning designs that keep essential thinking visible. Current secondary-school evidence mainly shows promising practices, such as dialogic questioning, rather than broad or long-term effects. The same features that make Generative AI useful can also create risks. The conversational, immediate and flexible output method may expand the support scope, but it might also hide errors, reduce effective input, and be more beneficial to students with stronger digital resources or adult guidance. Educational quality and equity therefore depend on safe systems, competent users, teacher mediation, and genuine opportunities to learn rather than simply obtain answers. Responsible integration should remain limited, transparent, and pedagogy-first. Students need structured opportunities to understand, question, verify, and disclose AI use, while teachers need time, professional learning, and authority to design or refuse AI-supported activities. Schools should use applications whose contribution can be shown in student work and revised when needed. This review is limited by the rapid pace of technological change and the still-developing evidence base in secondary schools; several influential studies concern primary or higher education and should therefore be transferred cautiously. Future research should use longer-term, comparative, and classroom-based designs to examine achievement, critical thinking, student independence, teacher workload, assessment validity, and distributional effects.

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