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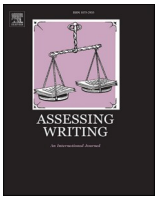

Towards a better understanding of integrated writing performance: The influence of literacy strategy use and independent language skills

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ABSTRACT

This study explores the influence mechanism of literacy strategy use and independent language skills (e.g., reading and writing) on integrated writing (IW) performance. 322 Secondary Four students from four schools in Hong Kong completed single-text reading, multiple-text reading, independent writing, and IW tasks, along with questionnaires investigating their reading strategy use and IW strategy use. Path analyses revealed that multiple-text reading and independent writing had comparable significant impacts on IW, mediating the influence of single-text comprehension. In addition, reading strategy use impacted IW indirectly through independent literacy skills and IW strategy use, while IW strategies exerted a direct influence on IW. Our findings underscore the critical role of language skills in mediating the influence of reading strategies on IW performance among young first language (L1) learners. The implications for research and practice, are discussed, emphasizing the complexity of the IW construct and the need for balanced language skills and strategy instruction to enhance IW task performance.

1. Introduction

Integrated writing (IW) tasks have gained increasing importance and popularity in language assessments (Daneshfard & Saadat, 2023; McDonough, Uludag, & Lindberg, 2019; Plakans & Gebril, 2017) because of their established predictive validity (Lewkowicz, 1994), increased authenticity (Cumming, 2013; Grabe & Zhang, 2013; Plakans & Gebril, 2013), and positive washback effect (Cumming, 2013). Addressing the complex demands of IW tasks, also known as reading-to-write tasks, necessitates not only learners'

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independent language skills, i.e., independent reading and writing skills (e.g., Esmaeili, 2002; McCarthy et al., 2022; Plakans, Liao, & Wang, 2019) but also strategic competence, i.e., the ability to employ strategic behaviors to facilitate language processing (Plakans, 2008, 2009b; Yang & Plakans, 2012). While strategy instruction is widely promoted to enhance writing, its effectiveness tend to depend on learners' language proficiency because lower-proficiency students often struggle to apply strategies effectively due to weak foundational skills (e.g., Madhumathi & Ghosh, 2012). This discrepancy raises important questions about the influence mechanisms of literacy strategies on IW performance and whether independent reading and writing skills mediate this relationship. Investigating these mechanisms can help bridge the gap between strategy instruction and students' actual writing outcomes.

Regarding independent skills, extensive research has been conducted to examine the impact of independent reading and writing skills on IW performance (e.g., Cheong, Zhu, Li, & Wen, 2019; McCarthy et al., 2022 Plakans et al., 2019). Independent reading, a common practice both within and beyond school settings, refers to the use of reading comprehension skills solely in the process of meaning making of written text (Erbeli & Rice, 2021; National Reading Panel, 2000). Meanwhile, independent writing is the process of composing a text based on a given prompt as well as one's existing knowledge and language skills. Despite the divergent purposes of independent writing and IW (Plakans, 2008), consistent evidence has suggested the direct positive influence of independent writing on reading-to-write scores (Esmaeili, 2002; McCarthy et al., 2022; Yang & Plakans, 2012). However, mixed findings arose about the role of reading, with some evidence supporting their significant positive influence (Cheong, Zhu, & Liao, 2018; Plakans & Gebril, 2013; Plakans et al., 2019), while others reported a low correlation between learners' reading and IW proficiency (Delaney, 2008; Watanabe, 2001). This discrepancy becomes more pronounced when considering the diversity within reading skills (e.g., multiple-text and single-text comprehension in (Watanabe, 2001; Zhu, Li, Cheong, & Wen, 2021).

Beyond independent skills, strategy use also emerges as a key factor influencing language test performance (Bachman & Palmer, 1996; Purpura, 2004). In IW tasks, reading strategies enable learners to effectively comprehend and select information from written input (e.g., Gebril & Plakans, 2009; McCarthy et al., 2022; Plakans, 2009a,b), while IW strategy use further organizes the information into a coherent piece of writing and guides the entire writing process (e.g., Daneshfard & Saadat, 2023; Yang & Plakans, 2012). However, the quantity of strategy use may not necessarily contribute to quality of writing (Daneshfard & Saadat, 2023), i.e., a higher frequency of strategy use does not guarantee superior IW performance (Cohen, 1994). In fact, some studies suggest that while the frequency of reading strategy use may predict reading comprehension (Banditvilai, 2020; Phakiti, 2003; Wu, 2022), it does not always translate into significant differences in IW performance (Li, 2014). Moreover, research indicates that independent language skills, such as writing ability, may have a stronger influence on IW outcomes than strategy use alone. Specifically, McCarthy et al. (2022) found that although both general knowledge and reading strategy use contributed to integrated essay-writing performance, general writing ability emerged as the strongest predictor when included in the model. These findings highlight the strong role of language skills in IW. In other words, while strategy use is important, the underlying independent language skills may be the key factor that enhances or limits the effectiveness of the strategy use in improving writing quality.

Overall, the existing literature has suggested significant roles of language skills and strategy use in IW. Meanwhile, these findings also generated a debate about their impact mechanisms. Specifically, the potential mediating role of independent skills in the relationship between strategy use and IW performance warrants further exploration. Although previous research has investigated the bivariate connection between independent skills, strategy use and IW, the intricate interplay among these factors, particularly the diverse types of reading skills, remains underexplored. In addition, while previous studies have investigated the influence of reading strategy use on reading and IW strategy use on IW, there is a dearth of research on the relationship between literacy strategies, and their simultaneous consideration of the associations between independent skills and IW. To address these gaps, this study aims to examine the concurring direct and indirect effect of independent skills, reading strategy and IW strategy use on Chinese first-language (L1) learners' IW performance, hence offering insights that could significantly contribute to understanding the IW construct and inform educational practices for IW learning.

2. Literature review

2.1. Relationship between literacy strategy use and IW performance

To complete IW tasks, learners need both language skills and effective *strategies* to comprehend information from inputs and generate a written response on a specific topic (Plakans, 2009b; Yang & Plakans, 2012). In such tasks, reading strategies are essential for learners to comprehend the texts before responding (Plakans, 2009b). By comparison, IW strategies further direct learners on how to integrate the comprehended information with their own knowledge to produce a cohesive written piece (Spivey, 1997, 2020; Wang & Zhang, 2021; Yang & Plakans, 2012). Given the critical role of strategies in language tasks, it is important to investigate the influence of reading strategy and IW strategy use on IW.

Reading strategies refer to "conscious, internally variable psychological techniques aimed at improving the effectiveness of or compensating for the breakdowns in reading comprehension" (Karimi, 2008, p. 5) Traditional research distinguishes between global and local strategies, with the former focusing on overarching understanding and discourse organization, and the latter attending to word-level meanings and textual details (Abbott, 2006; Barnett, 1988; Carrell, 1989; Young & Oxford, 1997). Extending on these perspectives, Mokhtari and Reichard (2002) developed the Metacognitive Awareness of Reading Strategies Inventory (MARSI) and identified three types of reading strategies used frequently by readers: (1) *Global* strategies encompass deliberate and carefully planned approaches to monitor their reading processes; (2) *problem-solving* strategies represent the localized and focused techniques to address the problems comprehending texts; (3) *support* strategies refer to basic support mechanisms designed to assist readers in comprehending texts. These three types of strategies, which were later revised in the inventory by Mokhtari, Dimitrov and Reichard (2018),

function independently and interactively to assist learners in comprehending texts.

Given the close connections between reading and writing, reading strategy use has been found to influence IW performance (e.g., McCarthy et al., 2022). According to Hayes (1996), reading strategies that facilitate learners in comprehending written texts are also essential to writing. Evidence has shown that high-performing learners in IW tended to use more reading strategies to effectively comprehend and select information from input sources (Cohen, 1994; Esmaeili, 2002; Gebril & Plakans, 2009; McCarthy et al., 2022; Plakans, 2009b), especially global strategies and mining source text ones (Plakans, 2009b). These findings indicate that students with more reading strategy use tend to be more capable of producing quality essays in IW tasks.

Additionally, research has also been conducted to investigate the influence of IW strategies (e.g., Yang & Plakans, 2012; Nelson & King, 2023), which both comprehending and composing functions are at work, and guide the whole IW process. In general, IW tasks involved three major discourse synthesis processes: organizing (i.e., dissembling the structure of source texts and supplying organizational patterns), selecting (i.e., selecting the key information based on certain criterion) and connecting (i.e., generate linking materials to integrate the given sources and incorporate them with their own perspectives) (Nelson & King, 2023; Spivey, 1984, 1997; Spivey & King, 1989). Specific to the context of IW assessments, Yang and Plakans (2012) further identified three categories that best describe the construct of IW strategies, including self-regulatory strategy, discourse synthesis strategy, and test-wiseness strategy based on a sample of 161 L2 English learners. The study showed that the former two kinds of strategies exerted a direct positive influence on IW, while test-wiseness strategy had a negative impact. A more recent study conducted among adult L2 learners found that both language proficiency and self-regulatory strategy use could exert a direct influence on learners' academic IW performance (Teng & Zhan, 2023). These findings suggest the essential role of IW strategy use in successful task completion.

While the aforementioned findings suggest that both reading strategy and IW strategy use influence IW performance, there is a lack of research that simultaneously investigate the influence of reading strategy use and IW strategy use. In addition, although extensive qualitative research has been conducted to investigate the influence of reading strategy on IW (e.g., Plakans, 2009b), few quantitative studies have been conducted to yield more generalizable findings.

2.2. Relationship between independent skills, and with IW performance

Research has established a close relationship between independent language skills, specifically reading and writing (Graham, 2020). According to shared knowledge theory, reading and writing are "constellations of cognitive processes that depend on knowledge representation at various linguistic levels (phonemic, orthographic, semantic, syntactic, pragmatic)" (Fitzgerald & Shanahan, 2000, pp. 39–40). These shared components include metaknowledge, domain knowledge about substance and content, knowledge about universal text attributes, and procedural knowledge and skills. Therefore, skills such as single-text reading, multiple-text reading, and independent writing are thought to share common features (Tierney & Shanahan, 1991), which influence learners' performance in IW tasks.

Previous research has confirmed moderate relationships between single-text and multiple-text reading. Single-text reading involves understanding and interpreting information from a single source. By comparison, multiple-text reading is more challenging as it requires synthesizing information from various sources, identifying relationships between texts, and resolving potential contradictions (Bråten et al., 2014; Cromley et al., 2021; Karimi, 2017). Despite such differences, studies have found moderate correlations between single-text reading and multiple-text reading, with correlations ranging from.27 to.58 (Bråten & Strømsø, 2011; Florit, et al., 2020; Strømsø, et al., 2010). Moreover, Britt & Sommer (2004) conducted two experiments to verify the effect of single-text reading on the comprehension of subsequent related texts. The results show that a well-constructed initial representation of a single text facilitated integration between multiple texts, hence verifying the effects of single-text reading on multiple text reading.

Researchers have also found a moderate correlation between reading skills and independent writing (Shanahan, 1984). Previous research has shown that reading influences various aspects of independent writing by instigating organizational and transformational operations in writing tasks (Risemberg, 1996) and providing the necessary knowledge and strategies, such as goal setting, summarising, analysing, and monitoring (Hayes, 1996). Similarly, a longitudinal study by Ahmed et al., (2014) found that reading proficiency consistently contributes to the quality of writing from first to fourth grade. More recently, Graham et al.'s (2018)meta-analysis of 54 experiments and 36 investigations revealed that reading instruction plays a key role in improving the overall writing performance of students from pre-K to 12th grade, with an effect size of .57.

Furthermore, the connection between input and output independent skills contributed to the complex nature of IW tasks (Machili, Papadopoulou, & Kantaridou, 2020; McCarthy et al., 2022). Specifically, in completing IW tasks, learners' performance is contingent upon their ability to comprehend textual materials (Cheong et al., 2018; Plakans et al., 2019; Sawaki, Quinlan, & Lee, 2013) and their capacity to effectively integrate textual information alongside their linguistic resources to compose coherent written responses (Esmaeili, 2002; Gebril, 2006; Lewkowicz, 1994; Machili et al., 2020; Yang & Plakans, 2012). Despite the proven connection between reading and writing, the distinct contributions of reading and writing skills to the production of high-quality integrated essays remains underexplored (McCarthy et al., 2022), especially when considering diverse types of independent skills.

Independent writing requires learners to generate ideas based solely on a prompt and their memory, drawing primarily on existing knowledge and language proficiency (Chan, 2017; Zhu, Li, Cheong, Yu, & Liao, 2021). Comparatively, IW challenges learners to identify, select, and synthesize source ideas; organize and express those ideas in writing while transforming source language; and adhere to stylistic conventions for source acknowledgement (Knoch & Sitajalabhorn, 2013). Despite these distinctions, extensive studies have identified the significant influence of independent writing on IW (Cumming, Rebuffot, Ledwell, 1989; Gebril, 2006; McCarthy et al., 2022; Yang & Plakans, 2012). For example, Cumming et al. (1989) demonstrated that independent writing skills enhance students' ability to integrate information at various levels in IW tasks.

Conversely, the literature presents mixed findings regarding the influence of reading skills (see a meta-analysis in Chan & Yamashita, 2022). Some findings highlighted the critical role of reading in influencing IW (Cheong, Zhu, Li, & Wen, 2019; Cheong, Zhu, & Liao, 2018; Plakans & Gebril, 2013; Plakans, Liao, & Wang, 2019; Zhu, Li, Cheong, Yu et al., 2021) because effective IW task completion required writers to comprehend the provided materials and integrate these sources with their perspectives appropriately (Plakans, 2008, 2009a). However, other studies indicated a low correlation between independent reading skills and performance in IW tasks (Payant et al., 2019; Watanabe, 2001). Some scholars found that students' independent writing was a stronger predictor of IW performance than independent reading (McCarthy et al., 2022; Watanabe, 2001), suggesting that writing exerted a stronger influence on IW than reading.

However, the instruments in these studies were primarily single-text reading and did not explicitly assess multiple-text reading skills, which involve integrating information from various sources into a coherent mental representation (Bråten et al., 2014; Cromley et al., 2021; Karimi, 2017). In fact, research has suggested that multiple-text comprehension appears to be more crucial for IW success than single-text reading (e.g., Zhu, Li, Cheong, & Wen, 2021). Therefore, despite previous evidence suggesting a stronger influence of writing than reading, we cannot conclude that writing is generally the more influential factor without investigating multiple-text reading simultaneously. In sum, the aforementioned findings have underscored the significance of independent skills in influencing IW (Cumming, 2014; Plakans & Gebril, 2017). Despite these correlational insights, there remains a notable gap in understanding the simultaneous direct and indirect effects of reading and writing on IW, particularly when considering the diverse kinds of reading skills involved. This paper aims to extend the literature by offering a more comprehensive understanding of how these components (i.e., single-text / multiple-text reading, and independent writing) collectively influence learners' achievements in IW.

2.3. Strategy use, independent language skills, and IW performance

As previously mentioned, the shared knowledge theory (Fitzgerald & Shanahan, 2000) posits that reading and writing are interconnected processes that share foundational knowledge, such as metaknowledge, including word identification and production strategies, and procedural skills such as monitoring strategies. Exploring the relationship between strategy use and independent language skills is essential in this research as it reveals how these shared knowledge bases and strategies interact to influence learners' ability to effectively integrate reading and writing. Understanding this relationship can contribute to the understanding of the IW construct and inform instructional practices that enhance both strategic competence and independent language skills, ultimately leading to more effective reading-to-write outcomes.

Previous research has suggested the direct impact of reading strategy use on reading (Banditvilai, 2020; Wu, 2019, 2022). Some research suggested that readers who used more strategies (Banditvilai, 2020; Phakiti, 2003; Wu, 2022) and those more global (Carrell, 1989; Huang & Nisbet, 2014) tended to perform better in reading tasks. For instance, based on a random sample of 1322 Chinese secondary school students, Wu (2022) employed the Chinese version of MARSI and found that students' reading strategy use was one of the most powerful correlates of their L1 reading. In addition, the types of reading task could also influence the effectiveness of reading strategy use. For example, compared with single-text reading, multiple-text reading requires more strategic processing (Karimi, 2015). This finding suggested the complexity of the mechanisms for reading strategy use to influence reading performances, especially when considering the diverse types of reading skills.

However, while some scholars posit that reading strategies facilitating reading comprehension are also essential to writing (Hayes, 1996), the frequent use of reading strategies does not necessarily contribute to high IW performance (Li, 2014; McCarthy et al., 2022). For example, McCarthy and colleagues (2022)examined the relative impacts of reading and writing skills, along with reading strategy use, on the performance of L1 English speakers in multiple-source writing tasks. Based on linear mixed-effect analysis, their results suggested that the influence of reading strategy use on IW was much weaker than that of learners' reading skills. Moreover, once learners' writing was entered into the model, it became the strongest predictor, underscoring the extremely significant role of independent skills on learners' IW task performance (McCarthy et al., 2022). Similarly, Li (2014) found no significant differences in reading strategy use between high- and low-performing students during summarization tasks, but language proficiency had a significant impact on IW outcomes.

While these studies highlight the stronger role of language proficiency over reading strategy use, they primarily compare the independent effects of reading strategies and literacy skills. Despite evidence suggesting the influence of reading strategy use on reading (e.g., Wu, 2022) and the influence of reading on IW (e.g., Liao, Zhu, & Cheong, 2021; Zhu, Li, Cheong, & Wen, 2021), there is a lack of investigations about the potential mediating effect of reading and writing in explaining the influence of reading strategies on IW. Understanding this relationship could provide insight into whether IW tasks are predominantly influenced by writing skill, and offer more comprehensive implications for educators regarding the balance between teaching of strategies and cultivating independent skills.

In conclusion, the existing findings have proved the significant influence of independent skills on IW. However, considering the effect of strategy use, there remains unknown about the mechanism of these variables. In addition, while some research has been conducted to investigate the respective effect of reading and writing on IW (e.g., Zhu, Li, Cheong, & Wen, 2021), little attention has been paid to examining the simultaneous influence of these skills, especially when considering the diverse types of reading proficiency (i.e., multiple-text reading vs single-text reading). Understanding of this aspect can contribute to a more comprehensive understanding of the IW construct. Further, previous studies have proven a significant influence of reading (e.g., Cheong et al., 2018; Plakans et al., 2019) and reading strategies on IW performance (e.g., Banditvilai, 2020; Wu, 2022), while no attention has been paid to the relationship between reading strategy and IW strategy use in the IW context.

3. Research questions and hypotheses

To address the research gaps, this study aims to examine the direct and indirect influence of independent reading skills, writing skills and strategy use on IW performance among high-school learners in Hong Kong. The data collection and analysis are guided by the following research questions:

- ***RQ1***: *How do single- and multi-text reading and independent writing skills influence Chinese high-school learners' IW performance?*
- ***RQ2***: *How do reading and IW strategy use impact IW performance, and what roles do reading and independent writing play in this impact?*

We hypothesized a model to illustrate how strategy use and independent skills affect writers' reading-to-write performance (see Fig. 1). The model includes four major aspects: strategy use (reading strategy use, IW strategy use), independent reading skills (single-text reading, multiple-text reading), independent writing skills and IW performance. The model was proposed based on the following reasons. First, given the strong connection between reading and writing, we predicted that single-text reading (Cheong et al., 2018; Plakans & Gebril, 2013; Plakans et al., 2019), multiple-text reading (Zhu, Li, Cheong, & Wen, 2021) and independent writing (Esmaeili, 2002; Gebril, 2006; McCarthy et al., 2022; Yang and Plakans, 2012) would influence independent writing and IW performance. Additionally, given the influence of single-text reading on multiple-text reading (e.g., Zhu, Li, Cheong, & Wen, 2021; Florit et al., 2020) and independent writing (e.g., Kim et al., 2018), we predicted that single-text reading could also influence IW via the latter two skills. Second, because of the critical role of strategic competence, we hypothesized that learners' reading strategy use would have a general effect on learners' reading (Banditvilai, 2020; Phakiti, 2003; Wu, Valcke, & Keer, 2019; Wu, 2022). Meanwhile, IW strategy use would exert a direct effect on learners' IW achievement (Yang & Plakans, 2012; Teng & Zhan, 2023). Finally, while no previous studies have examined the potential relationship between reading strategy and IW strategy use, we hypothesized that reading strategy use would predict IW strategy use because of the higher-level role of the latter.

4. Methodology

4.1. Participants

The study's sample comprised 322 Secondary Four (i.e., Grade 10) students from four schools in Hong Kong. The gender distribution was nearly balanced, with a ratio of girls to boys at 1:1.17, including 154 girls and 168 boys. Participants ranged in age from 15 to 19 years, with a mean age of 15.78 years (SD = .70). The students were recruited via opportunity sampling, but measures have been taken to make the sample reflect the spectrum of Secondary Four students in Hong Kong in terms of school type. Specifically, three government-aided schools and one Direct Subsidy Scheme (DSS) school participated in the study, covering two major school types in the local context. DSS schools, while receiving government funding, enjoy greater flexibility in their curriculum design and admissions policies, allowing them to tailor their educational programs more independently compared to traditional public schools.

IW was added into the Hong Kong Certificate of Education Examination (HKCEE) in 2007 and Hong Kong Diploma of Secondary Education (HKDSE) Examination in 2012 (Zhu, Li, Yu, Cheong, & Liao, 2016). The participants, being Secondary Four students in this study, are familiar with IW tasks, as they are progressively introduced to such assessments during their secondary education.

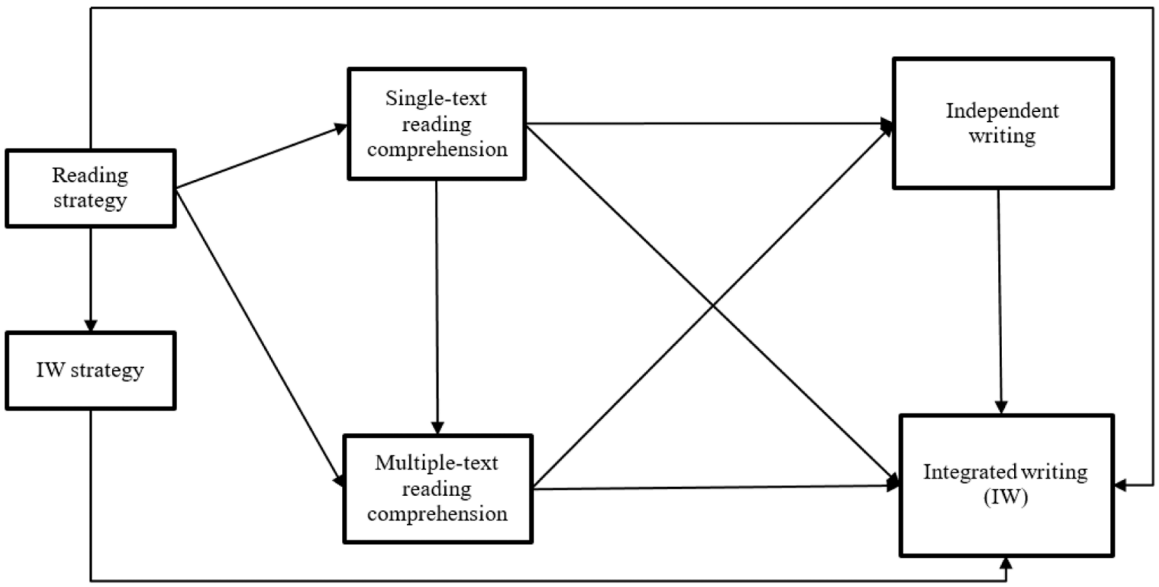

Fig. 1. Hypothesized model on the effects of literacy strategy use and independent skills on IW performance.

4.2. Measures

The study utilized six instruments to assess various aspects of independent reading and writing skills, as well as strategy use related to reading and IW tasks. The instruments included tasks for single- and multiple-text reading, independent writing and IW, and questionnaires to measure reading and IW strategy use. Each instrument is elaborated upon below.

The single-text reading task, developed by Cheong et al. (2018), involved a passage discussing the distinctions between criticism and critique in academic discourse. Participants were instructed to read the text and answer six short-answer questions within a 20-minute timeframe. The questions were designed based on the Six Reading Types framework in Zhu (2005), which evaluates the skills of retrieving, explaining, summarizing, elaborating, evaluating, and creating. The task had a maximum score of 20 points. The internal consistency reliability, as measured by Cronbach's alpha, was .62. Although this reliability coefficient was slightly lower than anticipated, it was deemed acceptable according to the guidelines by Hair et al. (2010), who recommended a threshold of .60 to .70 as the lower limit for acceptability in reliability estimates.

The multiple-text reading task, also developed by Zhu, Li, Cheong and Wen (2021) aimed to assess students' competence to process intertextual information. The task comprised five reading passages on the topic of artificial intelligence (AI). After reading the texts, students were asked to answer two multiple-choice questions (2 points) and three short-answer questions (15 points), with a total score of 17 points. The reading skills assessed in this task include: comparing and contrasting cross-textual information to create a coherent understanding; organizing information from multiple texts using strategies such as concept mapping, outlining, and summarizing; generating causal inferences by identifying relationships between cross-textual information; and evaluating one text in relation to another by using specific details from each text, such as comparing claims and evidence across two or more texts. To ensure the clarity and appropriateness of the task, two experienced language teachers were consulted in advance. Two raters, each with over six years of Chinese language teaching experience in secondary schools, scored the student task scripts. Reference answers for each question, developed based on students' actual answers, were provided (see Appendix). The internal consistency of the MTRC, as measured by Cronbach's alpha, was .71.

The independent writing task was sourced from the 2017 Hong Kong Diploma of Secondary Education Examination (HKDSE). Participants were instructed to write a narrative essay concluding with the phrase, "Since then, I have finally untied the knot of my heart." Despite students' familiarity with this task, they had not encountered this specific prompt before. Essays were scored based on the three HKDSE criteria: content, structure, and language. Two experienced Chinese language teachers rated the students' essays, and inter-rater reliability for the three dimensions ranged from .87 to .90, as determined by the Pearson product-moment correlation.

The IW task in this study was developed by Zhu, Li, Cheong, Yu and colleagues (2021) and aligned with the task design (i.e., a listening-reading-writing task) of the HKDSE. This task included five reading passages, a 5-minute audio recording and a writing prompt. The audio recording contained contrasting views on the effectiveness of installing cameras in taxis. The reading part comprised five written passages (3140 Chinese characters) across various genres, such as news reports and government documents, presenting diverse perspectives on the installation of cameras in taxis. Students were asked to synthesize the reading and listening materials and formulate their arguments to compose an essay of at least 600 words in approximately 70 minutes. Two experienced Chinese language teachers scored the essays using scoring rubrics developed by Zhu et al. (2016), comprising four dimensions: contextual awareness, citation and synthesis, original opinion and argument, and written expression and organization. The maximum score for the task was 40 points. Inter-rater reliability for the four dimensions ranged from .71 to .81, as measured by the Pearson product-moment correlation.

The reading strategy use of participants was measured using a self-reported reading strategy use inventory adapted from Karimi (2015). The original inventory was developed based on the Metacognitive Awareness of Reading Strategies Inventory (MARSI) by Mokhtari and Reichard (2002), including 30 items rated on a five-point Likert scale. The scale ranged from 1 ("I never or almost never do this") to 5 ("I always or almost always do this"), assessing global strategies, problem-solving strategies, and support strategies. The MARSI is a well-established tool for assessing the reading strategy use of adolescents and adults in academic contexts and has been validated in numerous studies. The version used in Karimi (2015) consisted of 27 items tailored to single-text reading strategies. For this study, an additional item from the MARSI was included to account for strategies involving the use of tables, figures, and pictures in comprehension. The final inventory for this study comprised 28 items translated into Chinese, with 13 items for global strategy use, 8 for support strategy use, and 7 for problem-solving strategy use. The Cronbach's α of this instrument was .91.

Participants' IW strategy use was investigated using the Chinese version of the IW Strategy Questionnaire in Yang and Plakans (2012). The questionnaire included 24 items measuring students' self-regulatory strategy use (SELFS), discourse synthesis strategy use (DSS), and "test-wiseness" strategy use (TWS) in the initial, intermediate, and final stages. The students responded to the items based on the frequency of the use of these strategies for completing IW tasks, based on a 5-point Likert scale ranging from 1 (never) to 5 (always). While the original questionnaire was designed to investigate L2 learners' strategy use when completing IW tasks, the adjusted version for L1 writers validated in previous studies (Cheong et al., 2019) was adopted for this study. The Cronbach's α of this measure was .86.

4.3. Data analysis

Correlation and path analyses were conducted in response to the research questions. Specifically, a hypothesized parallel multiple mediation model was established (see Fig. 1) to uncover the relationship between strategy use, independent reading and writing, and IW. The bootstrap method with 1000 samples was used to test the mediating effects, and this model was estimated using the robust maximum likelihood estimation (MLR) method. Model fit was appraised using a suite of indices, including the comparative fit index

(CFI), the Tucker-Lewis index (TLI), the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA). Descriptive statistics and correlation coefficients for all variables were calculated using SPSS 25.0, while path analysis was conducted in Mplus 8.0 (Muthén & Muthén, 1998–2017).

5. Results

The results of the descriptive statistics, correlation analysis, and path analysis are presented below. Table 1 presents the descriptive statistics (means, standard deviations, skewness, and kurtosis) for each variable. Specifically, the absolute skewness values for all variables ranged from 0.10 to 1.24, and the absolute kurtosis values varied from 0.03 to 2.58, indicating that all variables were normally distributed. This conclusion is supported by skewness and kurtosis values falling within the −3–3 and −10–10 ranges, respectively, according to Kline's (2016) rule of thumb.

Table 2 reports the bivariate correlations between the study variables. The results showed that there was a moderate correlation between independent reading, independent writing, and IW, with correlation coefficients ranging from .31 to .52. Moreover, reading strategy use was positively correlated with single-text reading ($r = .23$, $p < .01$), multiple-text reading ($r = .14$, $p < .01$), independent writing ($r = .12$, $p < .05$), and IW ($r = .16$, $p < .01$). IW strategy use was positively correlated with single-text reading ($r = .12$, $p < .05$), multiple-text reading ($r = .12$, $p < .05$), IW ($r = .16$, $p < .01$), and reading strategy ($r = .32$, $p < .01$). These associations warrant further investigation into the interplay among these variables.

5.1. The influence of independent skills on IW performance

Model 1 (see Fig. 2) was tested to examine RQ 1, which focused on the relationship between independent reading, independent writing, and IW performance. The results showed that the model fit the data well, with $\chi^2(0) = 0.00$, CFI = 1.00, TLI = 1.00, RMSEA = .00 and SRMR = .00. The model showed complete model fit because it is a saturated model. A saturated model is one in which all relationships among variables are connected (as in Model 1). In this case, the number of parameters to be estimated—including regression coefficients, variances, and covariances—equals the number of elements in the variance-covariance matrix, which is 10. Thus, the degree of freedom of the saturated model is 0 and the chi-square value is also 0.

The model with the standardized path coefficients is shown in Fig. 2. The results showed that both multiple-text reading ($\beta = .35$, $p < .001$) and independent writing ($\beta = .34$, $p < .001$) positively predicted IW. Additionally, single-text reading exerted a strong positive influence on multiple-text reading ($\beta = .51$, $p < .001$), both of which predicted independent writing performance, with single-text reading exerting a stronger influence ($\beta = .37$, $p < .001$) than multiple-text reading ($\beta = .15$, $p < .01$). While single-text reading did not have a direct effect on IW, it did have an indirect impact through various pathways.

Table 3 presents the standardized estimates of the mediating effects. The results suggested that single-text reading indirectly affected IW via independent writing ($\beta = .13$, 95 % CI = [.06, .20], $p < .01$), multiple-text reading ($\beta = .18$, 95 % CI = [.10, .26], $p < .01$), as well as multiple-text reading and independent writing ($\beta = .03$, 95 % CI = [.01, .05], $p < .05$).

5.2. The influence of strategy use on IW

In response to RQ 2, Model 2 (see Fig. 3) was further examined to investigate the effects of reading strategy and IW strategy use. Model 2 fit the data well with χ^2 (4) = 4.54, CFI = 1.00, TLI = 1.00, RMSEA = .02 and SRMR = .02. The results showed that IW strategy use significantly exerted a direct positive effect on IW ($\beta = .10$, $p < .05$). Although reading strategy use did not directly influence IW, it exerted indirect influences through multiple pathways (See Table 4). Specifically, reading strategy use indirectly affected IW via IW strategy use, with a mediating effect of .03 (95 % CI = [-.001, .06], $p = .06$ [marginally significant]). Furthermore, reading strategy use could also indirectly affected IW via independent skills, such as single-text reading and independent writing ($\beta = .03$, 95 % CI = [.01, .05], $p < .001$); single-text reading and multiple-text reading ($\beta = .04$, 95 % CI = [.02, .06], $p < .05$); and single-text reading, multiple-text reading, and independent writing ($\beta = .01$, 95 % CI = [.001, .02], $p < .05$).

6. Discussion

Despite considerable research into the individual effects of independent skills and literacy strategy use on IW, the mechanisms of these effects, particularly the mediation role of independent skills in explaining the relationship between strategy use and task

Table 1
Descriptive statistics for the study variables (N = 322).

	Min	Max	M	SD	Skewness	Kurtosis
Single-text reading	0.00	16.00	7.75	3.02	−0.29	0.03
Multiple-text reading	0.00	15.00	10.39	2.69	−1.24	2.46
Independent writing	13.60	85.75	54.52	11.50	−0.10	0.42
IW	0.00	28.75	16.56	5.25	−1.19	1.89
Reading strategy	0.82	4.68	3.09	0.60	−0.56	1.23
IW strategy	1.00	5.88	3.16	0.62	−0.41	2.58

Table 2
Bivariate correlations of the variables.

	1	2	3	4	5	6
1. Single-text reading	1					
2. Multiple-text reading	.51**	1				
3. Independent writing	.46**	.31**	1			
4. IW	.40**	.50**	.52**	1		
5. Reading strategy	.23**	.14**	.12*	.16**	1	
6. IW strategy	.12*	.12*	.06	.16**	.32**	1

* $p < .05$.
** $p < .01$.

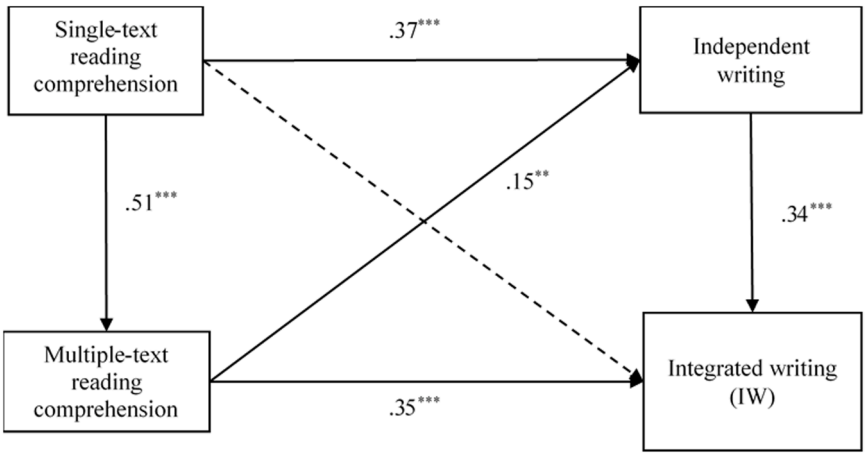

Fig. 2. The standardization effects of Model 1. *Note:* *** $p < .001$. ** $p < .01$.

Table 3
The potential pathways by which single-text reading affects IW.

Path	Indirect effect	95 % CI	*p*
Single-text reading → independent writing → IW	.13	.06,.20	$P < .01$
Single-text reading → multiple-text reading → IW	.18	.10,.26	$P < .01$
Single-text reading → multiple-text reading independent writing → IW	.03	.01,.05	$P < .05$

performance, remain underexplored. Our study was among the first to concurrently explore the influence mechanism of reading strategy use, IW strategy use and independent skills on IW, with specific attention to whether learners' strategy use could exert a direct or indirect effect. The results extended the current literature by identifying comparable impact of independent writing and multiple-text reading on IW as well as the mediating role of independent writing in explaining the influence of single-text reading. In addition, we also found the indirect influence of reading strategy use on IW via independent skills and IW strategy use. Furthermore, such studies were not found in the context of Chinese as L1. These findings made significant contribution to the understanding of the IW construct.

6.1. *Effects of independent reading and independent writing on IW performance*

Regarding the relationship between independent writing on IW performance, our findings, consistent with previous research (e.g., Plakans and Gebril, 2013; Yang & Plakans, 2012), reveal a significant moderate influence of independent writing on IW scores, despite the distinct purposes and discourse features of the two tasks (Plakans, 2008). This influence can be attributed to the analogous processes involved in both tasks, such as planning, writing, and revising, which may manifest with greater complexity in IW (Cumming, Lai, & Cho, 2016).

As for the effects of reading on IW performance, single-text reading did not directly influence IW, but it demonstrated significant indirect effects through independent writing skills or multiple-text reading. By comparison, we found a significant direct influence of multiple-text reading on IW (Zhu, Li, Cheong, & Wen, 2021). Notably, the effect of multiple-text reading was comparable or almost as important as independent writing. These findings contrast with previous studies that suggested a stronger influence of writing than reading (e.g., McCarthy et al., 2022). The difference may arise because previous studies, which identified independent writing as a stronger predictor than reading (e.g., Delaney, 2008; McCarthy et al., 2022), typically assessed single-text reading rather than

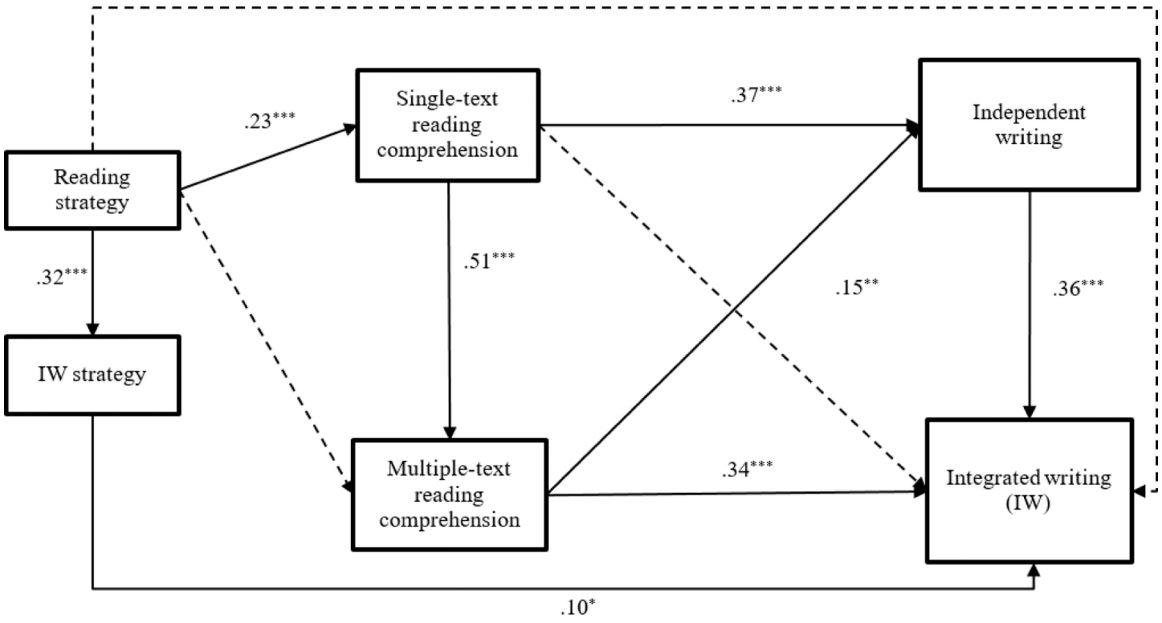

Fig. 3. The standardization effects of the proposed model. *Note:* *** $p < .001$. ** $p < .01$. * $p < .05$.

Table 4
The potential pathways by which strategy use affects IW.

Path	Indirect effect	95 % CI	*p*
1. Reading strategy → IW strategy → IW	.03	−.001, .06	$P = .06^{\dagger c}$
2. Reading strategy → single-text reading → independent writing → IW	.03	.01, .05	$P < .001$
3. Reading strategy → single-text reading → multiple-text reading → IW	.04	.02, .06	$P < .05$
4. Reading strategy → single-text reading → multiple-text reading → independent writing → IW	.01	.001, .02	$P < .05$

[c] † marginally significant

multiple-text reading. This might have led to misleading conclusions that independent writing played a more important role than independent reading in IW. Considering these findings, it is important to specify the type of reading—single-text or multiple-text—when analyzing the IW construct or the relationship between reading and IW.

One reason the effect of multiple-text reading is stronger than that of single-text reading could be that reading in the IW is more similar to multiple-text reading. The IW task design in this study required learners to understand five reading passages, highlighting the significance of multiple-text comprehension. This design aligns with real-world scenarios, such as academic writing, where students must navigate multiple sources to produce a cohesive written response. To yield a high-quality essay, learners must not only grasp the meaning of each individual text but also construct a coherent mental representation of multiple texts and draw inferences across documents (Karimi, 2017). The intertextual processing inherent in multiple-text reading is thus more pivotal than single-text reading and even mediates its influence.

In sum, the respective roles of learners' single-text and multiple-text reading alongside independent writing suggest the complexity of IW proficiency. Further research is needed to explore the complex interplay among learners' independent skills, especially considering variations in task types, to obtain a more comprehensive understanding of IW.

6.2. Relationship between strategy, independent skills and IW performance

This study contributes to the ongoing debate regarding the roles of strategy and language skills in integrated task performance. Our findings extended the literature by offering a more comprehensive understanding about the role of literacy strategy use and independent skills. We confirmed the mediating roles of independent skills in explaining the influence of reading strategy use on IW. By comparison, IW strategy use impacted IW directly. In addition, we also proved that reading strategy use could have a significant influence on learners' IW strategy use, underscoring the relationship between literacy strategy.

While a significant moderate correlation was identified between reading strategy and IW, consistent with previous research (Cohen, 1994; Esmaeili, 2002; Plakans, 2009b), our path analysis revealed that reading strategy use did not have a significant direct effect on IW. Instead, reading strategy use influenced IW indirectly through the mediation of single-text reading and independent writing or multiple-text reading, suggesting that the impact of reading strategy in enhancing IW performance was contingent upon learners' independent reading, multiple-text reading, and writing skills. Our results extend the findings from McCarthy and colleagues

(2022) who found that independent writing was a stronger predictor than reading strategy. Indeed, the frequency of learners' reading strategy use when completing reading-to-write tasks does not necessitate high quality of integrated written output because low-performance learners could have adopted a large number of strategies without using them appropriately (Cohen, 1994). Our study further indicates that reading strategy use influences IW performance indirectly through single-text/multiple-text reading and independent writing. Specifically, reading strategy use directly enhances students' single-text reading skills. When students can more accurately grasp specific ideas and details within single texts, they are able to more effectively retrieve and integrate information from subsequent related texts (Britt & Sommer, 2004). This improvement in reading comprehension aids students in expressing their ideas more precisely during writing task (Graham et al., 2018). These enhancements in reading and independent writing skills, in turn, promote IW performance. Furthermore, despite evidence suggesting that multiple-text comprehension is more demanding and requires strategic processing (Karimi, 2015), a direct significant effect of reading strategy was observed only on single-text comprehension, not on multiple-text comprehension. A possible explanation for this could be that the self-reported reading strategy inventory used in this study primarily assesses learners' strategy use in general, which at its inception is developed for single-text comprehension, potentially overlooking the intertextual processing strategies integral to multiple-text comprehension.

In addition, reading strategy use also had an indirect positive impact on learners' IW performance via IW strategy use which itself demonstrated a significant direct positive influence on IW (Yang & Plakans, 2012; Teng & Zhan, 2023). While no prior studies have explored the relationship between reading strategy and IW strategy, our findings suggest that reading strategy use may facilitate the application of IW strategy. This result indicates that learning of strategies, be it for reading or IW, are highly related, and plausibly transferable. This insight highlights the significance of both types of strategies and broadens our understanding of the IW construct from a strategic standpoint.

7. Conclusion

In response to the ongoing debate about the roles of strategy use and language skills in integrated language tasks, this study provided significant empirical evidence for the direct and indirect influence of literacy strategy and independent skills on IW. Notably, multiple-text reading had a strong positive effect on IW, comparable to that of independent writing skills, and both significantly mediated the influence of single-text comprehension. This highlights the necessity of distinguishing between different types of reading proficiency when investigating the IW construct. In addition, the path analysis showed that reading strategy and IW strategy use served distinct functions in affecting IW. While reading strategy use could only impact IW indirectly through independent skills and IW strategy, the latter could exert a direct influence. The result highlighted the essential mediation role of language skills in explaining the influence of reading strategy use on IW performance of L1 learners.

Despite these significant findings, we must acknowledge several limitations of this study and provide directions for future research. Firstly, the instrument used to assess reading strategy use was designed for single-text comprehension, which may not fully capture the strategies pertinent to multiple-source IW tasks that are prevalent in academic and everyday contexts. Future research should consider exploring the influence mechanisms of strategies for multiple-text reading and IW. Secondly, the mediation effects identified in this study are based on cross-sectional correlation and regression analyses, which may not fully capture the causal relationships. The cross-sectional design is also difficult to provide evidence for the changing pattern of the relationships between variables under investigation. Therefore, we plan to adopt a carefully refined design using mixed methods such as qualitative and experimental approaches, and enhance the participants' engagement in future research to further elucidate the effects of strategy use and independent skills on IW proficiency. Thirdly, the reliability of some instruments in this study was only marginally acceptable, warranting a cautious interpretation of the results.

Nevertheless, the findings in this study provided significant implications for language teaching and learning. Given the direct impact and complexity of multiple-text reading on IW, educators should prioritize teaching students to integrate multiple texts into coherent mental representations and draw inferences across documents, particularly when faced with diverse or conflicting viewpoints (Karimi, 2017). Taking a process-oriented approach, educators are recommended to guide students to firstly comprehend, then distinguish and organize, and finally select and integrate relevant source information in terms of their written arguments during the actual task completion procedure. Additionally, our results showed that improving learners' reading strategy use could also lead to more IW strategy use and higher performance in independent language tasks, thereby enhancing their IW. Essentially, in Chinese language classrooms of Hong Kong, teachers tend to teach the strategies in isolation, and also focus only on single-text reading. They explain the language concepts explicitly and assume that students will be able to use such strategies instantly. However, this does not usually happen, as students still lack the linguistic ability to apply the strategies. To enhance the linguistic ability of students, our findings suggest that teachers should facilitate more multiple-text reading activities, and connect the teaching of strategies in reading and IW tasks in such contexts, which will optimize curriculum time and enhances learning outcomes. Last but not least, the strong impact of independent language skills on authentic integrated tasks is still a most prominent result worth highlighting. It is advisable to take full consideration of students' independent skills when designing and developing strategy instruction. For example, teachers could adjust the IW task difficulty that is well-aligned with students' reading and writing skills by setting different time constraints and topics. Initially, students should be given more time to complete an IW task with a topic that they are familiar with. As students are gradually equipped with suitable reading and writing skills, teachers could shorten the time constraint and lower the topic familiarity of IW tasks.

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CRediT authorship contribution statement

Zhu Xinhua: Writing – review & editing, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Sun Yiwen**: Writing – review & editing, Writing – original draft. **Liu Yaping**: Writing – original draft, Formal analysis, Data curation. **Xu Wandong**: Methodology. **Cheong Choo Mui**: Writing – original draft, Writing – review & editing, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization..

Declaration of Competing Interest

The authors have no relevant financial or non-financial interests to disclose.

Appendix

Multiple-text comprehension scoring rubric (17 points)

Questions	Suggested answers
1. Passage 1 mentions that artificial intelligence (AI) is "machine learning through pre-arranged rules." Which two reading passages discuss how machines learn? Please select the correct answer and fill in the corresponding circle.	1 point B
2. Based on the two reading passages you selected in the previous question, summarize the process of machine learning.	3 points The process of machine learning involves first creating a large-scale database manually (1 point). Then, based on predefined rules (1 point), repeated testing is conducted (1 point).
3. The last paragraph of Passage 2 mentions: " The machine's diagnostic results are highly consistent with those of professional ophthalmologists, even slightly surpassing them. However, Peng Haoyi also emphasizes that the purpose of machine learning is to assist doctors in their work, not to replace them, and the medical community welcomes the achievements of machine learning." Which of the following individuals' statements most closely aligns with the viewpoint expressed in the above passage? Please select the correct answer and fill in the corresponding circle. (A) Chinese Go champion Ke Jie: "No matter how advanced AI becomes, it cannot replace the joy that human players bring to the game." (B) Entrepreneur Kai-Fu Lee: "We didn't come into this world to do boring, repetitive tasks. With the arrival of the AI era, humans should no longer do such things in the future." (C) Scientist Lan Hong: "Technology is indeed good, but its purpose should not be to replace the brain; rather, it should save time and physical energy, making the future better for humanity." (D) Tesla founder Elon Musk: "The potential harm caused by AI far exceeds that of nuclear weapons."	1 point C
4. If you were to submit an article to a scientific journal discussing the benefits of AI for developing countries, which reading passage would you choose to support your argument? Please explain your reasons.	4 points I would choose **Passage Two** as the basis for my argument (1 point). Passage Two mentions the medical research achievements of Google (1 point), illustrating that AI can assist doctors in diagnosing diseases (1 point), which is of great help to developing countries that lack medical resources / can help improve the quality of medical care in developing countries (1 point).
5. Each of the reading passages presents different perspectives on AI, illustrating the pros and cons of technological development. Based on the content of Passages 3–5, please complete the following table.	
Reading Passages: Please judge the main idea in the reading passage. If present, please tick √; if not, please cross × .	Summarize the content of the viewpoint
Example: Passage 2: Positive viewpoint ☑ Negative viewpoint ☒	Content of the viewpoint: From the perspective of improving healthcare quality, it explains that AI helps increase the diagnostic rate of retinal diseases, which is greatly beneficial for disease prevention.
Passage 4: Positive viewpoint ☒ (0.5 point) Negative viewpoint☑ (0.5 point)	3 points Content of the viewpoint: From the perspective of science fiction (1 point); propose three major principles that robots must follow (1 point); ensure human safety / prevent harm to humans (1 point).

(*continued on next page*)

(*continued*)

Questions		Suggested answers
Passage 5	1 points Positive viewpoint ☒ (0.5 point) Negative viewpoint☑ (0.5 point)	3 points Content of the viewpoint: From the perspective of cybersecurity / citing the results of a university research report / pointing out the attack capabilities of AI / AI's remarkable learning abilities (1 point); predicts the potential dangers of malicious use of AI (1 point), and calls for countermeasures (1 point).

Data availability

The authors do not have permission to share data.

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