Understanding self-directed learning in AI-Assisted writing: A mixed methods study of postsecondary learners

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ABSTRACT

This study investigates how postsecondary learners employ generative AI, specifically ChatGPT, to support their self-directed learning (SDL) for writing purposes. Following a sequential mixed methods design, we analyzed 384 survey responses and 10 semi-structured interviews with postsecondary writers. Findings suggest that the major learning task that the learners used ChatGPT for writing is brainstorming and seeking inspiration for ideas. While the entering motivation for using ChatGPT varies from curiosity about innovative technologies to fulfilling academic requirements, such entering motivation transformed into task motivation when the learners perceived the potential benefits of ChatGPT for assisting their writing. In terms of self-management, participants mostly demonstrated a high responsibility towards their own learning with ChatGPT and employed various strategies for SDL. Although survey respondents demonstrated a comparatively low level of self-monitoring, most interviewees claimed that they critically reflected on their learning process and validated information provided by ChatGPT. There are mixed opinions regarding whether the writing skills have improved as a result of using ChatGPT. Some participants suggested that the benefits brought by ChatGPT, such as alleviating social pressure and receiving instant feedback at any time, encouraged them to spend more time practicing writing and making revisions. However, some argue that assessing their AI-assisted SDL learning progress in the short term is challenging. This study addresses gaps in the existing literature where there is scarce, large-scale empirical research on self-directed AI usage in writing, shedding light on the emerging phenomenon of utilizing generative AI as a means of SDL in writing.

1. Introduction

In today's world characterized by rapidly changing social conditions and technological advancement, self-directed learning (SDL) is recognized as a fundamental competency for adults and a significant 21st-century skill (Morris, 2019). This recognition has become more pronounced with the widespread recognition of possible applications of generative artificial intelligence (AI) technologies in various fields. The rising popularity of AI technologies has sparked both interest and concerns regarding their potential usage in learning and teaching, highlighting the importance of focusing on SDL, a crucial skill for navigating an evolving educational environment and fostering lifelong learning.

While the use of traditional AI such as expert systems and automated writing evaluation for writing learning has been studied for years (Huang et al., 2023), employing generative AI, such as ChatGPT, to assist in self-directed writing learning is a highly novel area. Generative AI possesses the capability not only to utilize labeled datasets for training or supervised learning but also to generate sophisticated human-like content based on learned patterns. Launched at the end of 2022 and rapidly evolving, ChatGPT has gained significant attention for the potential benefits and disruptions it can bring to writing education (Barrot, 2023). This study examines how postsecondary writers utilize ChatGPT to facilitate their SDL in English writing, addressing a notable gap in the current literature where there is a scarcity of empirical evidence showing how self-directed learners adopt ChatGPT and manage their SDL writing process. Additionally, we aim to shed light on the emerging phenomenon of utilizing generative AI as a means of self-directed writing learning.

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2. Literature review

2.1. Self-directed learning with AI technologies

Self-directed learning (SDL) has long been researched as a construct to understand how learners take control and direct their own learning. Garrison (1997) defines SDL as "an approach where learners are motivated to assume personal responsibility and collaborative control of cognitive (self-monitoring) and contextual (self-management) processes in constructing and confirming meaningful and worthwhile learning outcomes" (p. 18). According to Garrison, *motivation* can be divided into entering motivation, which brings a learner to a learning situation or task, and task motivation, which pertains to motivation that keeps a learner engaged and persistent in the learning process. *Self-monitoring* involves a learner's responsibility to regulate and reflect on their own learning and monitor their learning strategies, thus involving both cognitive and metacognitive levels of thinking. *Self-management* refers to the management of one's own learning resources, time, and environment to take control of their learning task. These three elements are interrelated (Doo & Zhu, 2023). This study adopts Garrison's (1997) framework to understand SDL in AI-assisted writing among postsecondary students.

There has been a growing interest in researching how different technology-mediated contexts and digital learning tools play a role in SDL. Studies have explored how smartphones and mobile learning apps can support SDL outside the classroom (Jeon, 2022). For instance, apps like Duolingo and Busuu were found to have benefits such as flexibility and ubiquity for self-directed language learning (Li & Bonk, 2023; Klimova, 2018). SDL has also been richly discussed in online learning environments, MOOCs, and other open educational resource platforms where students are increasingly guiding and directing their own learning (Zhu et al., 2022; Zhu & Bonk, 2022). Additionally, recent studies have begun to examine agent-guided immersive learning environments such as when extended reality provides hands-on experiential opportunities for self-directed STEM learning (Iqbal & Campbell, 2023).

Using generative AI in SDL is a fast-emerging research area; as a result, empirical studies in this area are scarce (Lin, 2023). Among the existing empirical evidence, Lin (2023) investigates the use of ChatGPT as a virtual tutor to set specific learning goals, design learning resources, provide personalized feedback, and offer interactive guidance for self-directed adult learners in asynchronous online settings. However, challenges such as inaccurate resources and over-reliance on AI, which can lead to a lack of critical thinking, are evident. Similarly, Mogavi et al.'s (2024) qualitative study on 1500 posts from major social media platforms echoes this concern. The researchers found that although early adopters of ChatGPT in educational settings acknowledge the usefulness of ChatGPT in providing learners with customized feedback and assisting them in setting personalized learning objectives and lesson plans, there are widespread concerns about academic dishonesty, superficial learning, and potentially harmful impacts on learners' critical thinking. This dichotomy suggests that generative AI can facilitate SDL, but it may also provide shortcuts for learners to bypass some cognitive processes that can be important for effective SDL. Hence, despite the adaptability of generative AI tools to various learning styles, needs, approaches, and goals, Ali et al. (2023) underscore the importance of maintaining a high level of cognitive engagement and self-assessment so that learners take the responsibility of evaluating and reflecting on their own learning processes and products. Overall, these studies show that there is a need for more comprehensive research to uncover how learners utilize ChatGPT in the SDL process to further understand the impacts of generative AI tools on their learning.

2.2. AI assisted writing

AI technologies have long been adopted to support learners' writing development. For instance, automated written evaluation has been used for error correction and feedback (Alexopoulou et al., 2017) and chatbots are commonly used for writing assistance (Huang et al., 2023). Lin and Chang's (2023) mixed-methods study explored the effects of a chatbot on postsecondary students' thesis statement writing in an introductory educational psychology class. They found that the chatbot positively influenced students' learning experiences and served as an effective instructional supplement to teach writing. In an even more recent mixed-methods study, Zhang et al. (2023) examined 15 Chinese postsecondary writers' perceived impacts of a chatbot on their learning about logical fallacies in argumentative English writing. Their findings suggest that the educational AI chatbot improved students' writing proficiency while reducing their self-efficacy. These studies suggest that AI chatbots have the potential to improve students' specific writing knowledge and skills. However, studies alike were often conducted in structured or experimental settings, leaving informal and naturalistic SDL environments less explored. Furthermore, as Rad et al. (2023) point out, many of the studies of chatbot writing aids were brief experiments with a limited number of participants, highlighting the need for large-scale studies on self-directed learners' engagement with AI in the multifaceted writing processes that are not only cognitive but also social in nature.

The advancement of large language models like OpenAI's ChatGPT, Google Gemini, Claude AI, given their sophistication and easy accessibility, have sparked new research into their impact on writing education. Yan's (2023) qualitative study explored ChatGPT use in a one-week second language writing practicum. The findings show that the students were more concerned about the AI's threat to academic integrity and educational equity than its benefits. This interesting finding, as Yan suggested, could be due to the study's short duration and the instructor's emphasis on academic honesty. However, despite ChatGPT's potential influence on writing in academic, professional, and informal contexts, so far there have been minimal empirical studies demonstrating how learners actually utilized ChatGPT in supporting their learning about writing (Barrot, 2023).

As pointed out by Su et al. (2023), ChatGPT has the potential to support students' various writing tasks, including outlining, revising, proofreading, and reflecting. Learners are likely to learn about such AI tools outside their formal classroom settings and may be increasingly engaged in self-directing their learning with these tools. There is an urgent need, therefore, to understand how learners use ChatGPT and other generative AI technology for SDL in writing so that educators can better support students in the ethical and effective use of AI. To address this gap in knowledge, we designed this large-scale, mixed methods study to investigate how postsecondary writers utilized ChatGPT to facilitate their SDL in writing. The research questions that guided our study are as follows: (1) For which learning tasks in the writing process do postsecondary writers use ChatGPT? (2) How do postsecondary writers self-direct their use of ChatGPT to facilitate their writing? (3) How do the writers perceive the impact of ChatGPT on their writing skills?

3. Method

This study followed a sequential mixed methods design (Creswell & Plano-Clark, 2017) to explore how postsecondary learners employed generative AI to support their SDL in writing. We chose this method because it combines the breaths of quantitative data with the in-depth, contextual insights of qualitative data. Furthermore, diverse data sources allow for a more comprehensive interpretation of the findings. A mixed methods approach is particularly beneficial for exploring the use of generative AI in writing, given its relatively new phenomenon and the complexities involved in writing processes, which is not only a personal activity but also a social activity.

3.1. Data collection

3.1.1. Online survey

The research began with the collection of quantitative data through an online questionnaire created on Qualtrics[1] and the recruitment of participants through Prolific.[2] Prolific is an online platform that facilitates the process of participant recruitment, pre-screening individuals who meet certain criteria to participate in the study, and supporting integration with other platforms (e.g., Qualtrics). We first created a short screening survey to identify participants who held a student status, living in the United States, and had experience using ChatGPT for writing purposes. For those who satisfied our criteria, through Prolific, we invited them to complete a questionnaire on Qualtrics that measured their SDL process for writing with ChatGPT.

The SDL questionnaire was developed following Garrison's (1997) SDL framework and adopting the instrument items from Teng and Zhang's (2020) questionnaire on learner engagement in writing processes. To enhance the content validity, two experts in the SDL field and one in the writing field reviewed the survey to examine if the survey included relevant and representative times to cover comprehensive content. In addition, to ensure the survey accurately measured its intended metrics, a pilot test was conducted with an external individual who was not an expert in the field for feedback regarding the clarity and relevance of the survey items. The researchers together discussed the pilot test feedback and made necessary revisions to improve the accuracy and clarity of the survey questions.

Eventually, the researchers finalized the survey with a total of 33 questions. Among these questions, 29 used a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Importantly, three questions concerned participants' demographic information (e.g., gender, level of education, and native language), and two other questions were related to their usage frequency and their perceptions of ChatGPT's overall impact on their writing. The survey was administered during a three-week period in October 2023, when generative AI tools were undergoing rapid developments and increasing popularity, and educational domains were still exploring its applications and assessing its initial impacts on student learning Thus postsecondary learners were still at the beginning stages of exploring the use of ChatGPT for SDL in writing and might have diverse experiences worthy of further investigation. A total of 384 valid survey responses from postsecondary writers located in the United States were received.

3.1.2. Interviews

A semi-structured interview protocol with 15 open-ended questions was developed based on the literature review on AI-assisted writing and AI-assisted SDL, as well as consultation with an expert in the field of SDL, and a preliminary analysis of the data obtained from the survey. Specifically, the interview protocol included three parts. The first section focused on the postsecondary learners' usage of AI during different components of the writing process. The second section focused on their SDL experience regarding their motivation, self-monitoring, and self-management when using AI for writing, informed by Garrison's three-dimensional framework. The last section of the interview protocol was tailored to further understand the participants' responses to the survey. Ten interviewees were strategically selected based on their willingness to participate, as well as the diversity of their age and their current education level. This approach was to ensure a broad spectrum of participant experiences and perspectives were included. Specifically, as shown in Table 1, three interviewees were in their twenties, three in their thirties, and four in their forties. Four of the participants were pursuing undergraduate degrees and six were attending graduate schools. Regarding the frequency of using ChatGPT for writing, one

Table 1
Demographic information of ten interview participants.

Participant pseudonym	Age	Current education level	Frequency of Using ChatGPT for Writing
Amelia	31	Graduate degree	Monthly
Bennett	31	Graduate degree	Rarely
Chandler	41	Graduate degree	Weekly
Danielle	29	Undergraduate	Monthly
Elliott	35	Graduate degree	Rarely
Fallon	40	Undergraduate	Weekly
Giovanni	45	Undergraduate	Daily
Howard	24	Undergraduate	Weekly
Ivan	41	Graduate degree	N/A
Joshua	22	Graduate degree	Rarely

participant used it on a daily basis, three weekly, two monthly, and three rarely.

Each participant was interviewed once for around 40 min. All the interviews were conducted and video recorded on Zoom, a videoconferencing tool. Each interview was conducted collaboratively by the research team in English. After each interview, the research team debriefed the interview process and jotted down thoughts and reflections on the interview, which helped the research team to see initial patterns and differences across the interviews. Meanwhile, any identified gaps and questions that needed participants' further input and member checks were promptly noted. This approach helped enhance the quality of interview data and the trustworthiness of the study.

3.2. Data analysis

To analyze the survey results, basic descriptive statistics were conducted in Qualtrics and Microsoft Excel.[3] All interview data were transcribed by Kaltura,[4] and then manually checked by the two researchers to ensure the accuracy of the transcripts. Inductive qualitative content analysis (Elo & Kyngäs, 2008) was conducted to analyze the interview data. The second author firstly conducted open coding on Nvivo Version 14[5] with the research questions in mind. Then she grouped the initial codes into a list of categories, a process of organizing codes into a higher order category and reducing similarities (Dey, 1993). Next, she engaged in the process of abstraction of the generated categories (Elo & Kyngäs, 2008), merging similar categories and refining their descriptions to form a final list of main categories. The first two authors met three times during the coding process to confirm the coding and finalize the categorization. The final main categories that emerged from the data are as follows: (1) ChatGPT usage in the writing process, (2) motivation for using ChatGPT in writing, (3) self-management of using ChatGPT in writing, (4) self-monitoring of using ChatGPT in writing, and (5) perceived impacts. The combination of the quantitative and qualitative data allowed us to obtain a deep understanding of postgraduate learners' perspectives on the use of ChatGPT in their writing.

4. Findings

4.1. For which learning tasks in the writing process do postsecondary writers use ChatGPT?

4.1.1. Survey participants' frequency of using ChatGPT for writing

As shown in Fig. 1, among the 384 survey respondents, a majority of the participants used ChatGPT to support their writing on a regular basis. More specifically, 34 participants (8.85%) reported that they used ChatGPT for writing daily and 163 participants (42.45%) used ChatGPT

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[1] Qualtrics: https://www.qualtrics.com/.
[2] Prolific: https://www.prolific.com/.

[3] Excel: https://www.microsoft.com/en-us/microsoft-365/excel.
[4] Kaltura: https://corp.kaltura.com/.
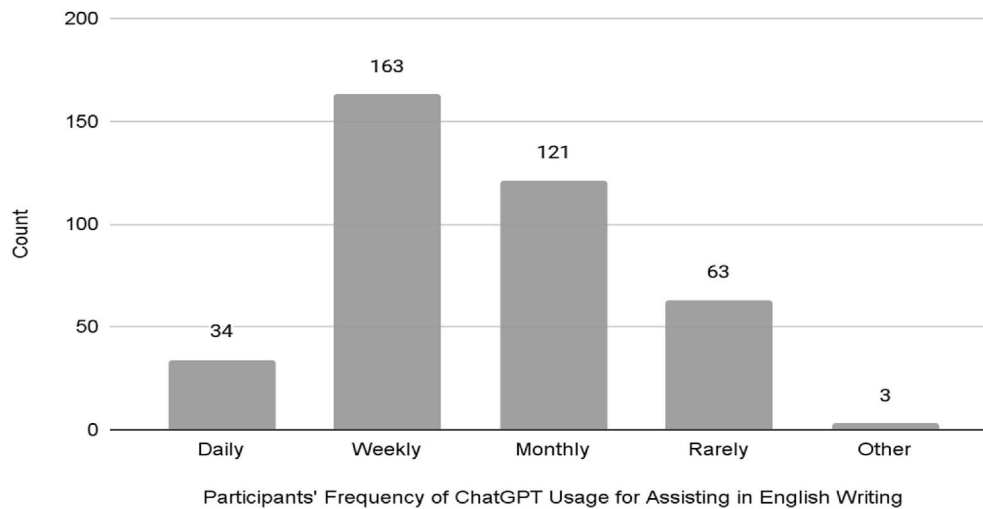[5] Nvivo: https://lumivero.com/products/nvivo/.

Fig. 1. Participants' frequency of using ChatGPT for writing.

for writing on a weekly basis. Interestingly, 121 postsecondary learners (31.51%) used ChatGPT monthly, while sixty-three participants (16.41%) rarely used it for writing purposes.

4.1.2. ChatGPT usage in the writing process

The survey measured how participants utilized ChatGPT to facilitate various components involved in their writing processes on a scale of 1 (strongly disagree) to 5 (strongly agree). As shown in Table 2, participants' utilization of ChatGPT for the purpose of brainstorming ideas for writing gained the highest mean test score (M = 4.23, SD = 0.96) among all learning tasks, followed by using ChatGPT to improve wording, sentence structure, or grammar (M = 4.10, SD = 1.10), and helping with outlining (M = 4.06, SD = 1.14) and improving the structure of writing (M = 4.05, SD = 1.04).

The interview findings align with the survey, especially highlighting that brainstorming and seeking inspiration for ideas is the most common learning task that individuals try to achieve with ChatGPT. For example, Ivan, a graduate student and a business owner, used ChatGPT to generate initial ideas for school papers and write advertising and marketing materials. He pointed out that ChatGPT served as an efficient tool for overcoming his writer's block by stimulating creative ideas. As he explained, "If I'm suffering from writer's block, the AI tool just gives me something to sort of work with when I can't think of an idea on my own. That's really helpful." He further noted that the biggest benefit of utilizing ChatGPT in this way was that individuals could now "get different ideas flowing in the head," instead of being limited to one's particular way of thinking. Similarly, Joshua, a graduate student in clinical mental health, suggested that ChatGPT has the ability to provide diverse ways of thinking, thereby enhancing his brainstorming process. He commented,

Table 2
Mean score and standard deviation of the specific components of participants' writing facilitated by ChatGPT.

Items	Mean	SD
1. I use ChatGPT to help brainstorm ideas for writing.	4.23	0.96
2. I use ChatGPT to help with outlining.	4.06	1.14
3. I use ChatGPT to help translate my ideas and thoughts into written words.	3.96	1.09
4. I use ChatGPT to improve my wording, sentence structure, or grammar.	4.10	1.10
5. I use ChatGPT to check the cohesion or connection among sentences.	3.82	1.22
6. I use ChatGPT to improve the structure of my writing.	4.05	1.04
7. I use ChatGPT to improve the content or ideas of my writing.	3.93	1.11
8. I use ChatGPT to check if my writing matches my goals or the requirements of an assignment.	3.60	1.37

"I think ChatGPT is really good with brainstorming and spitballing ideas, giving you a bunch of things to think about."

Another common learning task the interviewees engaged in with ChatGPT was editing and proofreading, particularly for grammar corrections. Giovanni, a bilingual undergraduate student in a bioengineering program, used ChatGPT daily to refine his grammar, noting the importance of having an AI tool for supporting his grammar learning and grammar correction in writing in a digital age. As he mentioned,

> Because of using cell phones for so long, with everything autocorrecting while texting, I've not been as focused on grammar. So I noticed my grammar started going downhill compared to back in the day … now, with texting and instant messaging, it's just getting sloppy. So I started second-guessing everything I was writing. So I'm using ChatGPT to see, okay, can you correct this grammar? What's wrong with this? And then syntax, of course. It's really helping bring back these skills to me again. So that's helping me quite a bit.

Likewise, Danielle used ChatGPT to edit her writing for various purposes, such as writing technical documentation, discussion posts, and proposals. She shared her routine of asking ChatGPT for grammar checking: "I'll be like, okay, this is my thinking and this is how I formulated them. Can you just catch any grammatical errors that my other [grammar-checking] tools didn't catch? Help me revise this a little bit." Similarly, a few interviewees also used ChatGPT for editing tasks such as refining lexical choices and condensing wordy language.

Interview data also revealed additional writing tasks that people used ChatGPT for but were not explicitly shown in the survey data. In fact, four of the interviewees mentioned that they frequently used ChatGPT to formalize their language and tone, particularly for writing in professional contexts. Bennett, for example, used ChatGPT to assist in transforming informal emails into formal business communications. As he explained,

> Sometimes I just have to type emails at work that I don't really know how to word it as formally as I would like to. So I'll just write the email out in a pretty informal way, put it into ChatGPT, and then ask it to rewrite this email as if it were a formal business communication. And so that's mainly what I use it for. Like if I'm sending an email to a manager or a director, I want it to be as formal as possible. So that's when I use it for English writing.

Overall, both survey and interview data collectively underscore the various approaches participants took to facilitate the different facets of the writing process, from initial idea generation to refining the final written product.

use ChatGPT (M = 3.87, SD = 1.02) were moderately rated. These results indicate that the participants generally held positive perceptions about their self-management skills when using ChatGTP to facilitate their learning about English writing.

Our interview data exemplified the participants' experiences. For instance, Fallon, an undergraduate student, recounted that she found traditional educational structures challenging for her and her son. Struggling in formal educational settings and looking for an educational experience tailored to her own learning style, Fallon recognized the transformative potential of ChatGPT plays in her and her son's learning experiences. As she mentioned,

> I have always been more self-directed. Always. I struggled in traditional schooling. I struggled greatly in high school and I struggled greatly in college until I learned my learning style … When my son became of school age, and I just, you know, I'm starting to pick up a lot of the same things that he's struggling with, I've struggled with, and I'm like, we're gonna do things differently. And that's when we went into homeschooling, and then we went into unschooling. I'm like this is exactly how we both learn, he's learning just like me, we have to kind of drive our own education, we can't do a structured way. ChatGPT definitely on makes it a whole lot easier. I wish I had this when I was younger. And I wish I had it when he was really a lot younger, it would have been a lot easier homeschooling, and coming up with curriculums and everything if I had it 10 years ago.

Fallon's narrative aligns with the highly rated statements about being able to hold responsibility for one's own learning and direct one's own learning progress while using ChatGPT, as showcased in the survey results. Particularly in Fallon's case, the self-management and self-direction of one's own learning are important skills that allow her to use the AI tool in a way that caters to her own learning style and in a less structured environment.

Content analysis of the interview data suggests that the interviewees developed the following different strategies to learn writing with ChatGPT: (a) designing specific and detailed prompts; (b) pre-prompting with context; and (c) knowing how to ask good questions. For instance, Chandler elaborated that ChatGPT provides more precise responses when users describe the task in greater detail. He explained, "I find that that works the best and that allows me sometimes to be a little more detailed. I find that if you ask it less, you won't always get the best response." Danielle recommended that enhancing the relevance and specificity of the generated content in ChatGPT can be achieved by providing context and background information about the writing task before presenting a prompt or question. She provided an example of how she pre-prompts ChatGPT when she needs it for a review by the "green team" in her work setting. As Danielle stated:

> I'm usually asking it for like, hey, I need to do a green team review of this proposal, could you help a little bit with some of the basics of that, and then explain; if you explain to it what a green team proposal is as well, it'll give you better feedback. So usually it requires a tiny bit of pre-prompting … the bot needs context to be useful. So when I needed to ask it for a green team review, I had to tell it what a green team was, what sort of feedback I expected.

Elliott further emphasized that one could start with and keep practicing ways to improve one's understanding and skill about asking good questions. He argued that:

> They should start with learning what the ways and the techniques are, and what the best way of getting your required answers is … If you don't know how to efficiently use ChatGPT, it might not yield the right thing you're looking for … You can only learn that over time. It took me four months to figure out. Initially, I was like, why is this overhyped, [but] I can't get to what I want. But you keep asking, and you keep asking. And eventually you figure out, okay, this is the best

way for me to ask for what I want. I think the more you ask, the more it [AI] learns and it learns based on your queries as well.

Overall, both survey and interview data suggested that learners attempted to be responsible for their own learning with ChatGPT. Interview data further revealed that learners incorporated a variety of strategies, such as improving their skills with prompt engineering to better work with ChatGPT.

4.2.3. Self-monitoring in ChatGPT-assisted learning processes

Table 5 displays the mean and standard deviation regarding participants' self-monitoring of their ChatGPT usage in supporting their writing learning. Being able to integrate the writing knowledge learned with ChatGPT with their work or life gained the highest mean score (M = 2.16, SD = 0.9), followed by critically evaluating new ideas related to writing learning provided by ChatGPT (M = 2.10, SD = 0.91) and asking follow-up questions with ChatGPT (M = 2.09, SD = 1.00). The very slight difference across these three items suggests that the participants overall demonstrated a comparatively low level of self-monitoring skills. To understand the reasons behind these lower scores, we asked participants to elaborate on their aspects regarding self-monitoring during interviews.

Interestingly, many of our interviewees claimed that they critically reflected on their learning progress, particularly by validating information provided by ChatGPT. For example, when Chandler asked ChatGPT for better word choices in his writing, he would validate the words provided by ChatGPT with a dictionary. He explained,

> Sometimes you don't necessarily want to use the same word over and over again, or maybe you know one word but you want to see what other words might work as well. So at times, I have used it to work, or maybe [when] you're not quite sure of the best word to use, and so I have asked it at times, and I'll validate it with a dictionary, and maybe see the way it sounds. But I have had it return some better word choices.

In this process of validating the accuracy of learning materials by ChatGPT, Chandler actively and constantly assessed the correctness of the information content as well as compared the material with his own criteria for accuracy. In other words, he monitored his own comprehension to ensure the information aligned with what was expected and adjusted his learning strategies accordingly.

Similarly, Ivan pointed out that having one's own subjectivity and voice in the process of evaluating the quality of AI-generated writing is necessary. Being aware of the limitations of AI-generated texts, Ivan adopted the strategy of only using the tool for ideation instead of creating writing drafts because it would eliminate his own voice. He commented,

> The quality of the essay is not always going to be good necessarily. It's more subjective whether or not you think it's a good essay. Plus ChatGPT and other AI tools can't really put something like an essay into my own words. And I wouldn't want to, either. I mean, I'm not trying to plagiarize or something like that … It can give me an idea like an argument, but I still have to start from scratch on writing the essay or term paper.

Table 5
Mean score and standard deviation of items related to participants' self-monitoring.

Items	Mean	SD
1. I critically evaluate new ideas related to writing learning provided by ChatGPT.	2.10	0.91
2. I ask follow-up questions regarding writing learning with ChatGPT.	2.09	1.00
3. I am able to integrate the writing knowledge I learned with ChatGPT with my work or life.	2.16	0.90

Fallon, on the other hand, was very critical of the possibility of faked information online. She believed that information or feedback by ChatGPT can be biased and therefore misleading. She suggested that learners should validate the information and be cautious about bias when using ChatGPT to improve writing. She cautioned,

> I think it's like anything with the Internet. You should double-check everything you should reference everything you see on the internet. I mean, even pictures aren't what they are. We can edit our pictures and make them completely distorted. Especially the high schoolers. Now, they know a lot about social media and they understand that a lot of things on social media are fake. ChatGPT is gonna give you mistakes and they're gonna guide you in the wrong direction, sometimes not intentionally, but you're definitely going to need to source everything that you get out of it.

4.3. How do the writers perceive the impact of ChatGPT on their writing skills?

Fig. 2 shows the participants' rating of the overall impact of ChatGPT on their writing. As indicated, 41.4% stated that the impact was very positive and 51.56% believed that the impact was somewhat positive, while only 5.99% of the participants rated the impact as neutral and the remaining 1.04% were somewhat negative. The participants generally viewed ChatGPT positively, which supports the findings of the first research question illustrating ChatGPT's diverse functionalities in aiding postsecondary learners with various learning tasks involved in the writing process. However, a small minority held negative perceptions. Our interview data shed light on these viewpoints. For instance, Bennett mentioned that using ChatGPT could "deteriorate the learning experience" because it could "basically do the work for you" in certain subjects and topics. Thus, he was concerned about the ethical implications of bypassing the essential trial-and-error process in learning, leading to reliance on the tool rather than developing one's own writing skills.

Fig. 3 further demonstrates how survey respondents perceived their writing development as a result of using ChatGPT. 30.73% of the respondents strongly agreed that they improved their English writing through ChatGPT's feedback, and 42.71% somewhat agreed with the statement. In terms of whether they found ChatGPT to be a helpful tool for writing, the vast majority of the participants strongly agreed (53.13%) and somewhat agreed (40.10%), while only 4.95% neither agreed nor disagreed. Less than 1% somewhat disagreed and another 1% strongly disagreed with the statement. This finding also corresponds with participants' rating of ChatGPT's overall impacts on their writing as positive, with a small portion of participants holding neutral and only about 1% negative views.

Our interview analysis elucidates such mixed opinions among participants regarding their perceptions of whether their writing skills had improved as a result of using ChatGPT. Some interviewees suggested that the benefits brought by ChatGPT, such as avoiding social pressure with others and providing instant feedback at any time, encouraged

them to spend more time practicing writing and making revisions based on ChatGPT's feedback. Such convenient and stress-free feedback process resulted in an improvement of their writing. For instance, Danielle claimed that she was "nervous" to ask for advice or help from people, and using ChatGPT allowed her to "spend more time on refining and revising the rough drafts and looking at what might be wrong with it." Interacting with ChatGPT for feedback and critically integrating the writing feedback by ChatGPT gave these learners an opportunity to reflect deeply on learning on their own.

However, some interviewees suggested that ChatGPT is not effective for beginners who are unfamiliar with how to formulate questions, and it may not exhibit a noticeable short-term impact on learning. For example, Elliott said learners may feel lost with generic feedback by ChatGPT when they cannot ask effective questions:

> [When] you wrote something you need to know what to ask and how to ask to get an efficient answer. It might be a generic answer that you wouldn't like, because initially, my experience is when I didn't know how to ask, I would get generic answers. And then I kept asking, had I kept asking, and eventually it got to that point, do it. Some people give up before that.

Elliot's experience highlighted that learners may experience a learning curve before they can navigate the tool effectively for facilitating writing. An exploration process is necessary for beginners to advance their skills in proficiently utilizing ChatGPT for their learning needs, as it involves understanding not only the functionalities of ChatGPT but also developing the skill to formulate questions and interpret AI responses effectively.

In addition to the challenge of navigating the usability of ChatGPT through prompt engineering and interaction with AI, Amelia pointed out another issue that caused her to question the usefulness of ChatGPT's feedback. She particularly critiqued ChatGPT's writing style for not aligning with her rhetorical purposes and needs, noting its tendency to either oversimplify or produce overly verbose writing. As she explained, "It [ChatGPT] condensed it [my writing] or made it a little bit more fluffier than I would want to. Sometimes it likes to get a little extra fluff. And I'm like I don't need all that. Or it might have taken my one sentence and made it three sentences, and I'm like oh that's a lot of run-on sentences there." Amelia's sentiment echoes other participants who held a neutral or negative view of ChatGPT's utility. This may stem from participants' limited experience and skills in crafting effective prompts, as Elliot pointed out, which is necessary to elicit the desired writing style from the AI. Additionally, it may also be attributed to inherent limitations within the large language model itself.

5. Discussion

5.1. Postsecondary writers' usage of AI in writing tasks

This study examined 384 postsecondary writers' perceptions and experiences of using ChatGPT to enhance their SDL in writing. The
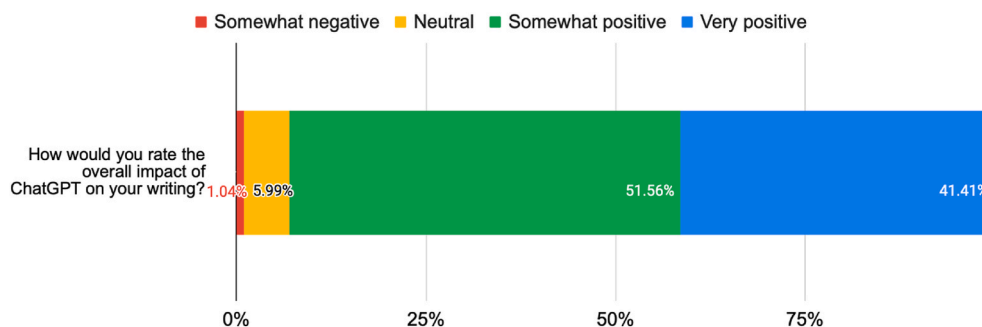

Fig. 2. Survey respondents' rating of the overall impact of ChatGPT on their writing.
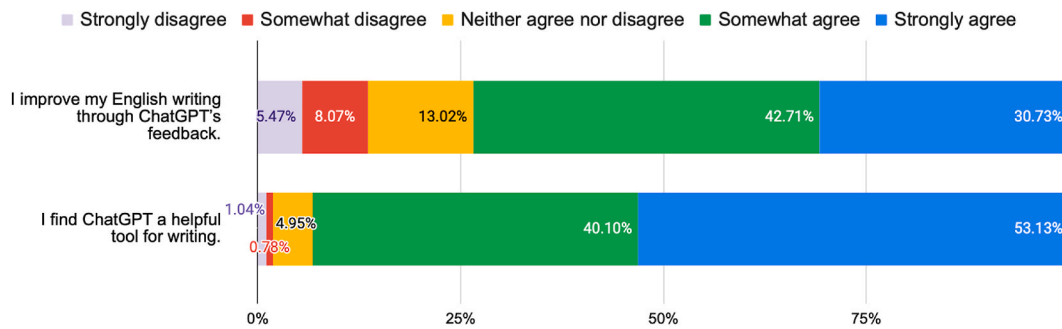
Fig. 3. Survey respondents' perceptions of ChatGPT on their writing development.

findings of this mixed methods study revealed that the postsecondary learners developed SDL skills throughout various components of their AI-assisted writing processes. The most common usage of AI in supporting SDL in writing includes brainstorming ideas, editing and proofreading, and helping with outlining and the structure of writing. This finding extends Su et al. (2023) which did not emphasize brainstorming, a key usage among participants in the present study. The reported usage addressed participants' learning needs for overcoming writer's block, embracing diverse ways of thinking, and understanding language choices and tones for different communicative purposes (e.g., professional and academic communications). The findings also highlight ChatGPT's functionalities in fostering both cognitive aspects (e.g., linguistic, genre, and content knowledge) and social dimensions (e.g., audience awareness and expectations) of learning about writing.

5.2. Postsecondary writers' SDL in AI-assisted writing

Adopting Garrison's (1997) SDL model, the study shows postsecondary writers' AI-assisted SDL in all three aspects of motivation, self-monitoring, and self-management. In terms of motivation, our findings reveal that the participants demonstrated a notable motivation to learn writing with ChatGPT. While their entering motivation varied, ranging from non-academic intrinsic motivation such as curiosity to extrinsic motivation due to academic requirements, they developed task motivation as they recognized how ChatGPT could support their specific learning goals and needs. We found that social interactions with learning communities, whether formal school-based groups or informal digital spaces like social media, played an important role in eliciting learners' entering motivation with the AI tool. In today's rapidly evolving digital landscape, traditional classrooms may not provide students with adequate opportunities to explore how emerging technologies may transform and enhance learning experiences (Morris, 2019). Some of our participants were acutely aware of these limitations in traditional, structured learning environments, thus embracing the more open and distributed learning opportunities offered by AI and technologies alike (Li et al., 2024).

However, we also acknowledge that instructors in formal educational settings can play a proactive role in helping students to experiment with the potential of AI tools, thereby enhancing students' task motivation. Given the widely shared ethical concerns about AI usage among our participants, it is increasingly important for educators to provide clear guidance and instructions to help students use AI effectively, ethically, and critically. Our finding supports the relevance and urgency of this approach, as the participants demonstrated a lower motivation to know the deeper reasons behind the feedback by ChatGPT despite their strong motivation to learn writing with ChatGPT. Given that motivation is "complex, multifaceted, and influenced by both person and context" (Hartnett et al., 2011, p. 31) and is a prerequisite for SDL (Loyens et al., 2008), demystifying AI, de-stigmatizing AI usage, and critically evaluating AI generated content can help to prevent the dismissal or ignorance of valuable learning opportunities for students in

an increasingly AI-mediated world.

As to self-monitoring, the present study uncovered postsecondary writers' various strategies for effectively monitoring their AI-assisted writing. These strategies included critical assessment of AI-generated information, proactive interaction with the AI tool to engineer prompts for optimal outcomes, and adapting the content to real-life situations. The strategies allowed the learners to self-assess their learning progress and tailor AI use toward their learning goals. As an internal and critical construct of SDL (Garrison, 1997), effective self-monitoring assumes the postsecondary writer's responsibility for taking control of their own learning and construction of knowledge. Our study indicated that utilizing generative AI for SDL demands a high level of cognitive and metacognitive abilities so that a learner can critically evaluate and reflect on the learning process, ensuring that generative AI usage does not harm student learning but rather triggers higher-level thinking. Learners, therefore, need to possess a considerable level of foundational knowledge such as prompt engineering, critical AI literacy, and subject matter expertise to make critical judgments of and adjustments to AI outputs. Information accuracy (Lin, 2023), algorithmic biases (Baker & Hawn, 2022), and linguistic and discourse appropriateness are different issues and concerns that need to be considered and evaluated when using generative AI to support writing. As Warschauer et al. (2023) have noted, generative AI presents various learning contradictions for learners that remain unsolved. Therefore, it is vital that learners have the necessary learning resources, content knowledge, and technological skills to self-assess their cognitive and metacognitive learning process.

Previous studies suggest that external feedback (Garrison, 1997) and social interactions (Alvi & Gillies, 2015) with a broader learning community can also enhance self-monitoring. However, the participants in our study were less likely to share their AI-assisted writing learning experiences with others. One of the factors, we speculate, may be due to the concern and sensitivity that many of the interviewees expressed about academic integrity and possible negative assumptions about AI users in writing. Another reason for the lack of openness in their use of AI technology for their writing effects may be that employing generative AI to support SDL in writing is a relatively new phenomenon, and therefore there have not been enough learning resources widely available and easily accessible to learners yet. Thus, the present study highlights that external feedback and resources are significant yet currently missed learning opportunities for many self-directed learners who want to advance their self-monitoring skills to better use AI to support writing. We recommend that instructors and designers of learning materials should emphasize the benefit of developing such disposition and provide tools and opportunities to help learners develop SDL skills through external feedback, such as learning collaboratively with peers and in teams to obtain updated information and timely feedback (Bannert et al., 2015). Instructors and institutions should play a proactive role in providing external support to enhance learners' self-monitoring (Zhu et al., 2020).

The third dimension of Garrison's (1997) model– self-management–

shows the behavioral aspects of SDL and is related to learners' task control such as managing time, support, and learning resources. Although the majority of participants in this study reported that they maintained effective time management and AI-generated learning resource management, digital distraction was a major challenge experienced by our participants. Future research studies need to be conducted to systematically examine the factors that influence learners' self-management of AI tools in their SDL (Lai et al., 2022) and strategies for advancing students' digital concentration while using AI for SDL about writing. Furthermore, the participants in our study demonstrated intensive use of external human and nonhuman resources (Li et al., 2024), such as native language speakers connected through social media, YouTube instructional videos, and peer support. Managing these diverse learning resources requires significant time as well as cognitive, technological, and social skills. Hence, we emphasize the importance of developing strong self-management abilities to effectively leverage the various resources for SDL with AI, which is particularly vital given the need to evaluate the accuracy and reliability of AI-generated content considering its potential limitations and biases.

5.3. Postsecondary writers' perceived impacts of ChatGPT on their writing skills

Existing studies have extensively discussed the benefits of generative AI for enhancing students' SDL in writing, particularly in aspects such as linguistic and writing knowledge and skills (e.g., Lin, 2023; Yan, 2023). Our study not only validates these findings but also expands the previous literature by shedding light on the affective benefits of using ChatGPT in facilitating SDL in writing. As noted by our participants, writing can be a stressful activity not only cognitively but also affectively, as one may face social pressure and anxiety (Nasri et al., 2015) when seeking human feedback to improve their writing, which is a common practice. AI feedback, however, can alleviate the stress caused by judgment, allowing learners to improve their writing through multiple self-directed rounds of feedback. We recommend that further research be conducted to better understand the affective as well as the cognitive impacts of AI tools on SDL.

However, a small number of participants held reserved or negative perceptions of generative AI's impact on their writing skills. These apprehensions primarily stemmed from generative AI's possible intervention across all facets of the writing process, which could potentially foster an over-reliance on the tool. While recognizing these challenges, it is important to note that using AI tools does not necessarily contradict the elements of SDL as defined in Garrison's (1997) model, which emphasizes motivation throughout the learning process, integration of cognitive and metacognitive self-monitoring activities, and effective self-management of learning tasks. Although generative AI can provide convenience for the learning process–a concern raised by some of our participants and echoed in the scholarly literature–we argue that it does not necessarily replace or eliminate the essence of meaningful learning experiences. These experiences must be actively constructed and made meaningful by the learners themselves. The opportunities brought by AI, accompanied by new challenges, pave the way for new methods and areas of learning and assessment. Success in SDL still requires learners' active involvement and adaptation to these new methods, such as enhancing critical digital literacy skills. Therefore, we highlight that incorporating AI tools should focus on complementing and enhancing these traditional elements of SDL rather than replacing them.

6. Limitations and future directions

6.1. Limitations of the study

It is important to acknowledge some limitations of this research study. First of all, our data is confined to learners' self-reported usage and perceived impacts on their SDL for writing with ChatGPT. Notably,

the validity of such a study could be addressed by gathering additional data from which to triangulate it with, such as the learners' written products, revisions, and AI log data to validate how they interacted with ChatGPT and how they incorporated AI outputs into their learning process. Furthermore, this study completed data collection in a comparatively short period of time, which may not fully capture the long-term impacts and adaptations of learners to the AI tool. Additionally, the study primarily utilized descriptive statistics and qualitative analysis, limiting our ability to make inferential conclusions about the influences of generative AI on students' SDL in writing. Our study is also limited in scope, focusing only on postsecondary learners in U.S. higher education during the fall of 2023. Given the rapid evolution of generative AI and the potential variability of AI acceptance and usage across different sociocultural and educational systems, our findings may not be generalizable to other contexts.

6.2. Directions for future research

We suggest that future research adopts experimental and longitudinal designs to examine the long-term impacts of using ChatGPT for self-directed writing learning. Further investigation should be also conducted across various generative AI platforms and AI-enhanced writing tools to evaluate their efficacy in promoting SDL in writing, and to pinpoint particularly advantageous features for learners. It is also crucial for future studies to extend beyond the context of U.S. higher education and to consider a range of learners, including both native and second language writers. We encourage researchers across various cultural and educational settings to address these distinct groups of writers in their SDL, as they may have different strategies and needs. Finally, case studies and qualitative studies are needed to understand more deeply the individual differences and provide an in-depth understanding of how generative AI tools and platforms can augment and support SDL in AI-assisted writing.

7. Conclusion and implications

Without a doubt, generative AI is making enormous impacts on our society during the past couple of years. Accordingly, the present research has unveiled the potential benefits that ChatGPT offers for SDL for writing purposes. The findings have uncovered that ChatGPT fosters both cognitive aspects and social dimensions of learning about writing. Novel and smart technologies, such as ChatGPT, inspire learners to become self-directed and lifelong learners due to their curiosity about innovative tools.

Notably, in this process of learning with generative AI, instructors from formal educational settings are likely to play a proactive role in helping students experiment with the potential of AI tools, thereby enhancing students' task motivation. Learners themselves also developed various strategies to better operate AIs for learning purposes, demonstrating that AI-enabled SDL triggers a higher level of thinking, though challenges in self-monitoring still exist. We believe that this research serves as a starting point for scholars to focus on how generative AI facilitates SDL. It also encourages further investigation into how educators and designers can provide improved guidance to address challenges associated with generative AI in the context of SDL for writing.

Based on our research, we offer the following practical implications and recommendations for supporting learners' AI-assisted SDL. Educators are encouraged to tailor activities to align with diverse student motivations and provide clear guidelines on ethical AI usage to demystify the technology. Students should be provided with opportunities to learn ways to critically evaluate AI-generated content as well as develop prompt engineering and critical AI literacy skills. Providing external feedback and resources, such as peer learning opportunities, can also enhance students' SDL learning with AI and prevent the dismissal of valuable learning opportunities. Educators should recognize

the cognitive and affective benefits of using AI tools for SDL while providing guidance for helping students address challenges such as over-reliance on AI to ensure that meaningful learning experiences are actively constructed by the learners themselves.

Statement on ethics

The study was approved by Indiana University Institutional Review Board with ID: 20611. Informed consent was obtained from all participants, and their privacy rights were strictly observed. The participants were protected by hiding their personal information during the research process.

Data availability

The data can be obtained by sending request e-mails to the corresponding author.

CRediT authorship contribution statement

Chaoran Wang: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Zixi Li:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Curtis Bonk:** Writing – review & editing, Validation, Resources, Project administration, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

A list of acronyms in the manuscript

SDL   Self-directed learning
AI   Artificial intelligence

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