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Generative AI and technological mediation: writing micro-processes, products and perceptions

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The public release of ChatGPT presents language education with both advantages and challenges. Being widely available and readily producing texts at user's command, it is an especially useful resource in ESL writing. However, to be able to leverage it effectively for that purpose, we need to understand the writing micro-processes surrounding its use. To this end, this study investigates, through an experimental design, writing micro-processes along with writing outcomes, and perceptions of 12 ESL writers across three writing conditions. The data included interviews, questionnaires as well as essay grades and screen recordings. Two of the three conditions involved the use of ChatGPT. The results indicate that the majority of participants favored the ChatGPT-assisted conditions and noted its role in aiding idea generation. Despite this preference, some participants noted that ChatGPT-produced texts felt robotic and lacked a human touch. We found no statistically significant differences across the three conditions in the participants' essays. Most notably, our analysis identified distinct clusters of writing micro-processes associated with the ChatGPT conditions, suggesting that generative AI tools can influence writing behaviors although the link to outcomes is not straightforward. These findings provide insights into the potential benefits and limitations of using AI tools in writing tasks. The article discusses areas for further research to enhance the integration of AI into ESL writing education.

Keywords: micro-processes, writing outcomes, perceptions

Introduction

The public release of ChatGPT in 2022 presents language education with both opportunities and challenges. Since its launch, educators have been striving to make sense of it as a tool readily available to students. Several studies have found Generative Artificial Intelligence (GAI) to be useful in helping L2 writers produce higher-quality texts (e.g., Yan, 2023), and despite some concerns, students generally hold positive views about its learning potential (Han et al., 2023; Chan & Hu, 2023). However, as Warschauer et al. (2023) point out, ChatGPT also poses dilemmas for language learners, including issues of academic integrity (Mogavi et al., 2024). What remains certain is that debates will continue over how ChatGPT can be used in language education.

Writing, in particular, is likely to be affected most, as it is the skill ChatGPT most directly influences, generating texts in response to diverse prompts. Against this backdrop, there is a pressing need to understand how English as a Second Language (ESL) writers use GAI to compose in English. While ChatGPT excels at producing fluent texts, how these outputs mediate ESL learners' writing processes remains a crucial question. Much of the existing discourse, both alarmist and enthusiastic, takes these mediating processes for granted. Yet any use of the tool reveals that AI-generated texts are rarely ready for seamless integration into one's writing. Responses are often too generic and require adaptation for effective use. Thus, multilingual students' processes of tailoring these texts to their needs become central to understanding ChatGPT-aided writing. Reflecting this, recent studies have called for research into ChatGPT-supported writing processes (Barrot, 2023; Wang, 2025).

Attempts to understand how ChatGPT is integrated into writing have yielded valuable insights, most often through interviews probing student perceptions (Wang, 2025; Yuan, Li & Sawaengdist, 2024). We extend this work by moving beyond interviews to direct observation, revealing the micro-processes L2 writers engage in during academic writing tasks.

To illuminate how GAI mediates writing practices, we focus on writing micro-processes across three configurations, both with and without ChatGPT. Drawing on data from screen recordings, participant writing, questionnaires and interviews, we argue that three dimensions, namely perceptions, micro-processes and outcomes are all essential to forming a compressive understanding of ChatGPT's role in writing. The objective of the study is, therefore, to investigate writing micro-processes mediated by the use of GAI along with writing outcomes and student perceptions.

Theoretically, the study is framed by the concept of technological mediation, informed by the extended mind framework (Clark, 2008) and mediation in L2 learning (Lantolf, 2011). This lens invites us to see how tools, in this case GAI, shape and mediate human action. We first introduce the literature informing the study, followed by a description of the theoretical framework.

GAI in language education: toward understanding writing micro-processes

This section reviews previous studies relevant to our research question, highlighting key findings and showing that GAI-mediated student writing processes remain underexplored.

In their systematic review of ChatGPT studies involving multilingual learners, Yang and Li (2024) report a wide range of both benefits and challenges. Commonly cited gains include improved language skills, positive attitudes toward GAI, and increased autonomy and L2 practice. Conversely, plagiarism, inaccuracies, and overreliance on GAI emerge as major drawbacks. These themes recur across the literature. For example, several scholars warn of potential learning loss from excessive GAI use (Barrot, 2023; Tseng & Warschauer, 2023). Zhang et al. (2023) illustrate this risk: postsecondary students trained with chatbots to identify logical fallacies showed improved argumentative writing but reduced self-efficacy.

Beyond its general use in language education, a growing body of research has examined ChatGPT as a writing tool, leading to an increasingly international literature (Li et al., 2024), pointing to its promise in improving writing skills (Kasneci et al., 2023). Among the various ways in which AI has been shown to support learners are vocabulary refinement, content development as well as grammar and vocabulary (Barrot, 2023; Su et al., 2023). A growing focus is on feedback and assessment (Guo & Wang, 2024; Jaing et al., 2023; Steiss et al., 2024). AI has also been found to support writers through differentiated feedback (Huang & Wilson, 2021; Bahari, 2021). Huang and Tan (2023) further advocate ChatGPT's use to streamline science writing, especially literature reviews. Notably, most of this research has been carried out through classroom observations, surveys or interviews, that is by and large data collected on writing without direct measures. Experimental work by Song and Song (2023) compared university students taught to use ChatGPT with a traditionally instructed control group. The experimental ChatGPT group showed significant gains in organization, coherence, grammar, and vocabulary. However, participants also noted limitations, especially inaccuracies and the need for "careful adjustment" of AI-generated text to ensure contextual fit.

In reviewing the possibilities of GAI for L2 writers, these limitations need to be considered as well. GAI-produced language may reinforce dominant norms, perpetuating biases that disadvantage marginalized learners (Bender, 2021). GAI-assisted writing can also mislead L2 learners through inaccuracies like fabricated references, alongside a noted desire for greater transparency in source generation (Liu et al., 2024). Additionally, students report concerns about inequity and reduced learning motivation (Yan, 2023). At the same time, AI-detection tools have been found to disproportionately misclassify second language (L2) students' writing as AI-generated (Liang et al., 2023).

Studies examining writing processes offer particularly relevant insights. Su et al. (2023) suggest that ChatGPT can assist with argumentative writing,

especially in outlining, revising, proofreading, and post-writing reflection. Although conceptual, their work highlights the potential GAI to support writing. Wang (2025) explored this further in a phenomenological study of L1 and L2 writers in freshman composition courses. Participants used ChatGPT for brainstorming, outlining, revising, and editing, but faced two dilemmas: fear of losing their voice and concern about learning loss. Similarly, Wang et al. (2024) surveyed 384 postsecondary students and found that, while ChatGPT fostered self-directed learning, some expressed anxiety about overreliance.

Zhao et al. (2024) likewise found that students from diverse linguistic backgrounds used ChatGPT to rephrase texts, check grammar, overcome mental blocks, summarize, structure writing, and clarify complex ideas. Such findings are valuable in showing how learners apply AI tools to specific challenges. However, most of these studies (Su et al., 2023; Wang, 2025; Wang et al., 2024; Zhao et al., 2024) rely mainly on retrospection rather than direct observation. Woo et al. (2024) depart from this trend by analyzing screen recordings of EFL students writing blog entries. They identified six categories of prompt use, including autocomplete, search engine, and natural language instruction. Similarly, Levine and Beck (2024) used direct methods to document students' engagement with ChatGPT across planning, translating, and reviewing stages.

Woo et al. (2024) further identified distinct profiles of AI use: the most proficient writers used AI outputs sparingly but strategically, while others showed limited or uncritical use. These process-oriented studies directly probe the writing process (e.g., Nguyen et al., 2024; Wang, 2025) and have brought to light the multiple purposes L2 writers put GAI (Hwang & Sun, 2025). These findings underscore the importance of examining how writers interact with AI in detail rather than in general terms. Responding to this concern, Wang et al. (2024) and Levine and Beck (2024) both call for further research into *how* students employ ChatGPT in writing tasks. Our review also brings out the need for more process-focused studies, emphasizing that understanding GAI-assisted writing requires closer analysis of AI-mediated writing micro-processes, a topic we explore in the next section.

GAI and mediation: writing micro-processes

Writing has always been shaped by the tools and technologies available, from clay tablets to digital screens. As Haas (1996) notes, language is "made material through the use of technologies" (p. 3). While texts have always been material, this materiality has become more visible due to advances in digital tools. The existence of technologies which allow us to track how texts come into being, mediated by various digital tools such as GAI, makes possible new lines of research into the technological mediation which attends writing.

Mediation can be understood through several theoretical perspectives. Central to Sociocultural Theory (SCT), based on Vygotsky's work (Lantolf & Thorne, 2006; see Li, 2006 for applications to L2 writing), mediation refers to

the "creation and use of artificial auxiliary means" for human action (Lantolf, 2011). A clock, for example, has the effect of reorganizing human behavior. SCT emphasizes how such means transform cognition and behavior. Similarly, the Extended Mind framework (Clark & Chalmers, 1998; Clark, 2008) views human cognition as extending beyond the brain, incorporating environmental resources such as technologies (Overstreet, 2022). Human expertise thus arises from "a heterogeneous assembly of brains, bodies, artifacts, and other external structures" (Clark, 1997, p. 77). Second-wave theorists stress the actions enabled through the "coupling" of people and environment (Clark, 2008, p. xv), a notion closely aligned with SCT's mediation and what Brooke and Rickert (2011) term a "dynamic engagement with the world and its entities" (p. 169).

Importantly, the effects of mediating technologies such as ChatGPT are not deterministic (Haas, 1996). For instance, GAI can be used to receive feedback on texts as well as generate entire essays. These are two different use cases. To understand their impact, we must examine the concrete processes through which mediation occurs and how tools are taken up and used in practice. In writing, this means analyzing activity at the microscopic level of practice (Overstreet, 2022) or writing micro-processes (Shahri & Karimi-Aghdam, 2025): the moment-to-moment operations, "minute practices, reflexes, and habits" (Spinuzzi, 2002, p. 10) that shape evolving texts and knowledge (Lillis & Curry, 2022).

Micro-processes, defined as moment-to-moment activities shaping writing, are deeply intertwined with new technologies, each making the other visible. The advent of screen-capture tools (Seror, 2013) now allows researchers to observe such momentary actions as writing unfolds. These micro-processes constitute the main site of digitally mediated writing. Understanding how GAI tools like ChatGPT serve writers' goals requires studying how they are orchestrated during composition. Without this lens, our understanding of how digital tools mediate text production remains limited. Technological mediation can therefore best be examined through attention to micro-processes.

Because this study centers on writing micro-processes, it is useful to situate them within cognitive models such as Hayes's (2012). Hayes conceives the writing process and task environment as dynamically interconnected. The task environment includes the evolving text, transcription tools, collaborators, and task materials. Within this framework, digital technologies like ChatGPT can be seen as collaborators or transcription aids, given their co-constructive potential. While Hayes (2012) does not explicitly address AI tools, this conceptualization allows their integration. Scholarship on digital writing (Kessler, 2020; Stapleton, 2010) further expands our understanding of how technologies mediate writing and facilitate subprocesses such as research and collaboration. Examining micro-processes thus provides a granular understanding of the interface between writing and digital tools as composition unfolds in real time.

As noted in the previous section, the micro-processes underlying ChatGPT-supported writing remain underexplored. While prior work has asked writers about their use of ChatGPT, few studies have examined this use through screen

recordings. Yet, such analysis is essential for understanding AI-assisted writing. Accordingly, this study addresses the following questions:

1. What effect does ChatGPT use have on ESL writers' essays?
2. What are ESL writers' perceptions of ChatGPT as a writing support tool?
3. What micro-processes do ESL writers engage in when using ChatGPT to compose their essays?

The next section details the methods used to collect data for analysis.

Methodology

The study was conducted in May 2023, a few months after the public release of ChatGPT. We employed a mixed-methods research design that integrated quantitative and qualitative data collection and analysis. The quantitative component consisted of a within-subjects (repeated-measures) experimental design. The qualitative component comprised two sources of data. First, screen recordings of participants' writing sessions were analyzed to examine their writing micro-processes. Second, post-experiment surveys and semi-structured interviews were conducted to explore participants' experiences, perceptions, and reflections on using ChatGPT during the writing tasks. Integrating quantitative and qualitative findings provided a more comprehensive understanding of both the outcomes of ChatGPT use and the writing processes underlying those outcomes. Below we describe the participants and procedures.

Participants and procedures

The study was approved by the university's Institutional Review Board (IRB). Participation was voluntary, and all participants provided informed consent prior to participation. Participants were informed of their right to withdraw at any time without penalty, and all data were anonymized prior to analysis. Twelve participants were recruited from a composition program for multilingual writers at a large U.S. university. All were first-year students enrolled in a composition course for multilingual students (they spoke English as a second language), representing several first languages including Arabic, Chinese, Spanish, Japanese, and Portuguese. The participants' proficiency level was advanced as they all had taken either IELTS or TOEFL and met the threshold for admission to US universities. Therefore, despite the expected variation in their writing proficiency, they were all following the same curriculum and were advanced writers. Based on their responses in the interviews, about half the participants were already familiar with ChatGPT prior to the study.

Prior to the experiment, participants created a ChatGPT account (ChatGPT-3.5) and familiarized themselves with the tool. Specifically, they were asked to create accounts a week in advance if they did not already have one and explore the interface on their own. There were no other further instructions provided. On the day of the study, the three writing conditions were explained in detail, and questions were answered. The first author was present throughout to clarify any uncertainties. All three conditions

were completed on the same day as well as the orientation and in a university classroom. All students completed the procedures on their own computers and submitted their text in designated Google folders. The students were proctored by the first author and did the procedures one by one in a classroom.

Each participant wrote three essays (one per condition), then completed a questionnaire probing their perceptions of the conditions and of GAI more broadly. Each essay required a minimum of 400 words and was written within 40 minutes. The writing took place in person with the first author present, while follow-up interviews were conducted online.

The study's three writing conditions were designed to capture varying levels of engagement with ChatGPT. To minimize potential prompt effects, the writing prompts were counterbalanced across the three experimental conditions. Prompts were selected from a pool of argumentative essay topics and comparable in terms of difficulty, familiarity, and the cognitive demands required to construct and support an argument. All prompts addressed general, non-specialized topics that were expected to be accessible to participants without requiring subject-specific knowledge. The order of prompts was counterbalanced across participants to avoid sequencing effects. That is, counterbalancing ensured that each prompt appeared equally often in each experimental condition, reducing the likelihood that differences in essay quality could be attributed to the prompts themselves rather than to the experimental manipulation. The order of conditions was not counterbalanced since condition 3 was designed to follow 2 and changing that order would have jeopardized that part of design.

1. Condition 1: Participants wrote an essay without using external sources or AI assistance, verified later through screen recordings. This served as the baseline condition.
2. Condition 2: Participants generated three ChatGPT essays using the "regenerate" function and read them before composing their own essays. This condition exposed participants to AI-generated examples, allowing them to reflect on ChatGPT's writing before producing their own text (see Levine & Beck, 2024).
3. Condition 3: Participants wrote using ChatGPT in any way they found helpful. They could generate or regenerate responses but were not required to.

In Conditions 2 and 3, participants were explicitly instructed not to copy AI-generated language directly into their essays. The progression from independent writing (Condition 1) to guided (Condition 2) and flexible AI use (Condition 3) enabled examination of how exposure to ChatGPT shaped writing micro-processes and perceptions of AI. Written and oral instructions were provided to ensure comprehension.

Data collection

Four data sources were collected: (1) the participants' 36 essays (three per participant), (2) questionnaire responses (questionnaires provided in the

appendix), (3) interview data (semi-structured with follow-up questions asked), and (4) screen recordings of the writing sessions (Geisler & Slattery, 2007; Seror, 2013). The questionnaires included items on participants' writing processes and attitudes toward GAI. The questionnaires were developed by the researcher to probe the participants' thoughts immediately after the study to complement the interviews which were conducted the day after.

Screen recordings captured participants' writing activity in real time, making their micro-processes observable. Writing activity here included all observable actions video recorded on the screen as writing unfolded. Specifically, the participants were asked to use either Zoom or Command+ shift+5 on their own computers to record their screen during the entirety of their writing spanning over the three conditions. In addition to the analysis, described below, these recordings were used to verify the instructions were followed.

Data analysis

Essay grades

Eleven participants completed all study procedures and followed the experimental instructions; one participant was excluded because the instructions were not followed. Essay quality was evaluated independently by two of the authors using an analytic rubric comprising four dimensions: content and organization, thesis focus and clarity, vocabulary, and grammatical structure. Each dimension was scored on a 10-point scale, yielding a maximum total score of 40 points per essay. To minimize potential bias, essays were randomized before scoring so that both raters were blind to the experimental condition under which each essay had been produced.

Initial agreement between the raters was 81%, defined as scores that differed by no more than two points on the 40-point scale. The final essay score used for analysis was calculated as the average of the two raters' scores. These averaged scores were used in the subsequent statistical analyses.

Screen recordings

Screen recordings were analyzed to identify micro-processes during writing, particularly in Conditions 2 and 3. Following Wingate and Harper (2021) and Hayes (2012), we examined goal-directed actions without separating planning, translation, and reviewing. Each author conducted an independent analysis which resulted in a list of goal-directed actions for each participant. Once all researchers completed their analysis, discrepancies were discussed and resolved. These were mostly minor disagreements. This five-stage process produced a refined classification and clusters of micro-processes across conditions.

Interviews and questionnaires

Interviews were structured around a number of questions. However, follow-up questions were asked to prompt participants to elaborate when necessary.

The questionnaire had 8 items and each interview lasted around 30 minutes. Both interviews and questionnaires were developed by the first author for this study. In both interviews and the questionnaires, the participants were asked questions about 1). what they did during the three writing conditions, 2). what they thought about them and 3). And more generally their attitudes toward the use of GAI for writing purposes.

Interview (transcribed through the data transcription tool otter.ai) and questionnaire data were coded to capture participants' perceptions of ChatGPT. Codes were refined iteratively (Gioia, Corley, & Hamilton, 2013) into parsimonious analytic units (Miles, Huberman, & Saldaña, 2014) until saturation was reached (Saldaña, 2015). An example of a code which emerged early on was the idea of using ChatGPT to organize texts. To complement the qualitative findings, keywords and adjectives describing ChatGPT and writing conditions were extracted to generate a word cloud (simplewordcloud.com), visually summarizing participants' overall perceptions. Interview and questionnaire coding was conducted solely by the first author; therefore, intercoder reliability of the interview and questionnaire data was not calculated.

Findings

The findings are presented in three sections. We first outline the results of the ANOVA to see whether there were any differences between the three writing conditions. We then turn to the participants' perceptions, followed by a description of writing micro-processes as revealed in screen recordings.

Essay grades

The first research question examined whether the use of ChatGPT affected the quality of participants' essays (the first research question). Table 1 presents the descriptive statistics for essay scores across the three experimental conditions. The mean essay score was 29.09 (SD = 2.43) in the no-ChatGPT condition, 30.91 (SD = 3.33) in the structured ChatGPT condition, and 31.73 (SD = 3.58) in the unstructured ChatGPT condition.

A one-way repeated-measures ANOVA based on the multivariate approach indicated no statistically significant differences in essay quality across the three experimental conditions, Pillai's Trace = .394, F (2, 9) = 2.92, p = .105, partial η^2 = .394 (Table 2). Although the observed effect size was large, the small sample size reduced the statistical power of the analysis to detect differences

Table 1. Descriptive statistics of essay ratings of the three conditions

Condition	*M*	*SD*	*N*
No ChatGPT	29.09	2.43	11
ChatGPT 1	30.91	3.33	11
ChatGPT 2	31.73	3.58	11

Note: *M* = Mean, *SD*: Standard deviation; *N* = Sample size

Table 2. Multivariate tests

Effect	Value	F	Hypothesis df	Error df	Sig.	Partial eta squared
Pillai's Trace	.394	2.921[b]	2.000	9.000	.105	.394
Wilks' Lambda	.606	2.921[b]	2.000	9.000	.105	.394
Hotelling's Trace	.649	2.921[b]	2.000	9.000	.105	.394
Roy's Largest Root	.649	2.921[b]	2.000	9.000	.105	.394

among the conditions. Prior to the analysis, the assumptions underlying the repeated-measures ANOVA were assessed and found to be satisfied.

Student perceptions

The analysis of the participants' perceptions of ChatGPT was based on two data sources: questionnaires administered immediately after the writing experiment and interviews conducted either the day after or two days after participating in the writing component of the study. The analysis sought to answer the following question:

What do ESL writers think of ChatGPT as a tool to support their writing in the two ChatGPT-assisted conditions?

To establish a baseline for the participants' views of ChatGPT in the study, we begin with what they said about condition 1 in which there was no ChatGPT assistance. There was a spectrum of sentiments about writing without the aid of GAI. Some referred to the frustration of having too many thoughts and not knowing how to organize them, including where to begin. Others mentioned running out of ideas and the difficulty of writing without access to sources other than their memories. On the other hand, a smaller number of participants (n = 3) described the condition in more positive terms, extolling it as giving them a sense of ownership over their voice (own voice) and being a more authentic task "because it is your own". Most participants (n = 7) said they believed condition 3 had yielded their best textual outcome, followed by a smaller number who said the same about condition 2. Three participants said condition 1 represented their best writing.

It is pertinent to remember at this point that the participants' views were expressed against a backdrop of the entire study including the other two conditions. Put another way, their perceptions are reasonably seen as implicit comparisons with the other two. For instance, when a participant talked about writing with no limitations, she was referring to the constraints embedded in the other two conditions in which they were required to use ChatGPT in prescribed ways (in condition 2 given explicit instructions to *generate 3 responses and read* them and in condition 3 *to use* ChatGPT). Table 3 is a summary of participant sentiments about the three conditions.

In terms of their thoughts about how they used ChatGPT during conditions 2 and 3, the majority of responses revolved around the use of ideas from the

Table 3. Participant sentiments about the three conditions

Condition	Participant sentiments
Condition 1	Positive: My own thoughts Negative: Difficulty coming up with ideas
Conditions 2 and 3 (ChatGPT mediated)	Organization, structure assistance, powerful, great way to get started because of ChatGPT ideas

generated responses, assistance with the organization of their essays and the use of structures from the responses and the specificity of examples.

Some interview and questionnaire items sought to probe their perceptions beyond the study, specifically their thoughts about ChatGPT's affordances including AI-generated texts. In this regard, their views spanned a spectrum. On the one hand, some said ChatGPT "sounded reliable", "it's a powerful tool", "helps with brainstorming", "great because sometimes it's hard to take the first step", provides "researched answers" and is "unbiased". Conversely, other participants criticized ChatGPT on grounds that it was "not personal", "robotic", having "no analysis" and "not developed". The analysis of participants' perceptions is encapsulated in the word cloud below (Figure 1).

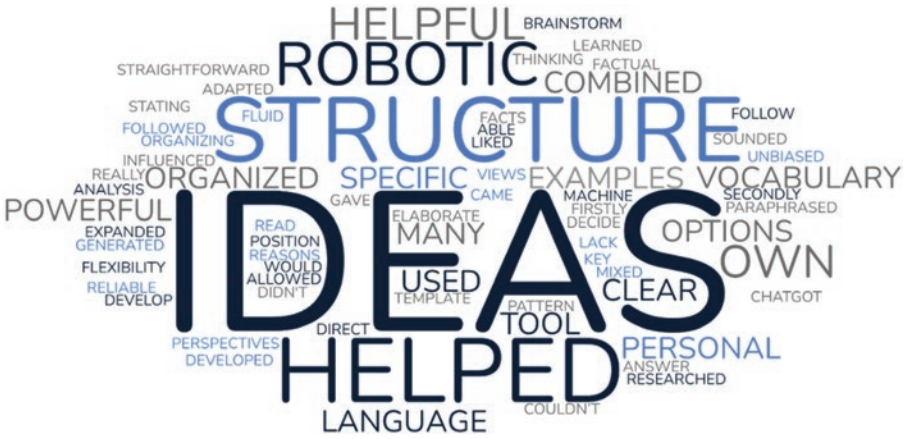


Figure 1. Word cloud representing the most common words participants used in interviews

In line with the analysis of participant views of the affordances of the two ChatGPT-assisted conditions, the keywords *ideas*, *structure*, *helpful and helped* stand out. Just as prominent, albeit pointing to a different attitude, is the word *robotic*. The word *robotic* was used to describe ChatGPT responses.

In closing, we note that most participants (10 out of 11) responded in the affirmative to a question about whether they would consider using ChatGPT in the future.

Micro-processes

In this section we illustrate the writing micro-processes in which the participants engaged. These documented micro-processes are the specific ways

ChatGPT mediated the participants' writing. In focusing on the participants' micro-processes, we are interested primarily in writing conditions 2 and 3, that is ChatGPT-mediated micro-processes. It is useful to recall that the analysis of micro-processes is based on observed micro-actions in screen-recordings, supplemented by what participants said during interviews when describing their micro-actions. This section provides the answer to the following question:

What micro-processes do ESL writers engage in as they use ChatGPT to compose their essays?

The analysis revealed a range of micro-processes as the participants used ChatGPT to compose their essays. Here we present these in the form of clusters of micro-processes to capture a general picture of the way ChatGPT was utilized, one representing the entirety of participants' interactions rather than focusing on individual differences in the use of the tool. By cluster we mean a coherent set of micro-processes, observable actions in student screen recordings, which occurred to perform a function.

Figure 2 is a schematic representation of micro-actions in the condition 2.

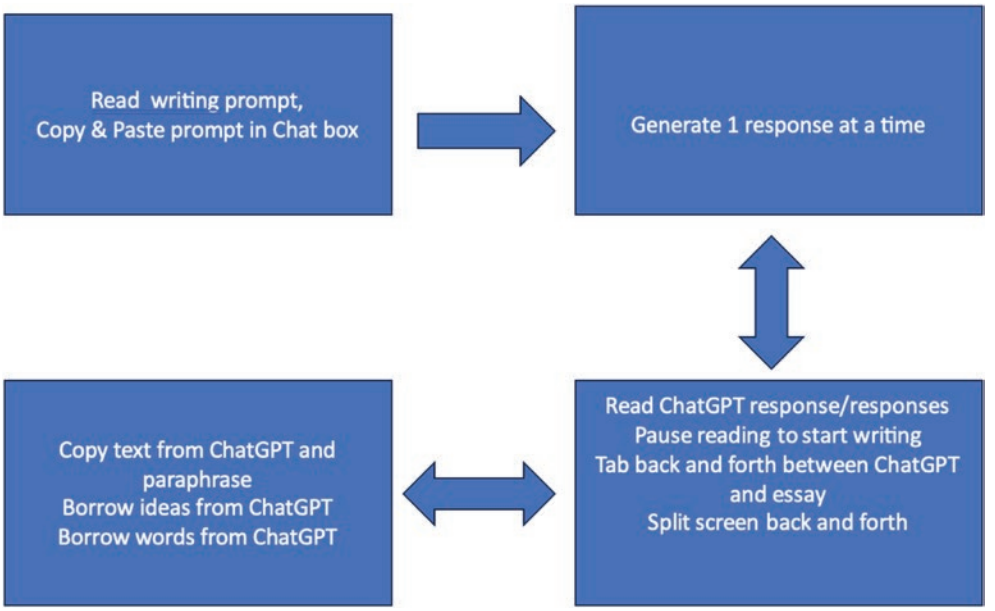


Figure 2. Cluster of micro-processes in writing condition 2

Note that in this article "prompt" refers to participants' input to ChatGPT while "writing prompt" refers to the essay questions the participants answered in each condition. The micro-actions included in the same box are those which either happened simultaneously or represent alternatives. Looking at the diagram, we can observe that the participants engaged in a straightforward sequence of actions. The linearity is, to be sure, a product of the instructions the participants followed. Some participants began by reading the prompt and then, in line with instructions, generating and regenerating three ChatGPT

responses. Others generated one response instead of all three at once, waiting to generate the other two later. They then read the AI responses, followed by a writing stage, the point at which they began writing. There was some variation here with some participants taking longer to read the responses and others appearing to skim them. Once they began writing, some went back and forth whereas others kept writing without consulting ChatGPT responses beyond their initial reading.

Although the cluster of micro-processes is not complex, there was some variation across the participants in the way they used ChatGPT, especially in the way they engaged with ChatGPT responses and repurposed the texts for their own essays. Some copied entire sentences or paragraphs and then edited them. Others borrowed ideas or words, as seen when they inserted fragments of language or conceptual structures from ChatGPT responses.

One of the participants (participant 6), for example, spent much of her time going back and forth between ChatGPT responses (copied in her Google folder) and her own developing essay. In one instance, she scrolled up to a part of the ChatGPT response on a scientific perspective on the idea of building space stations, as seen in Figure 3.

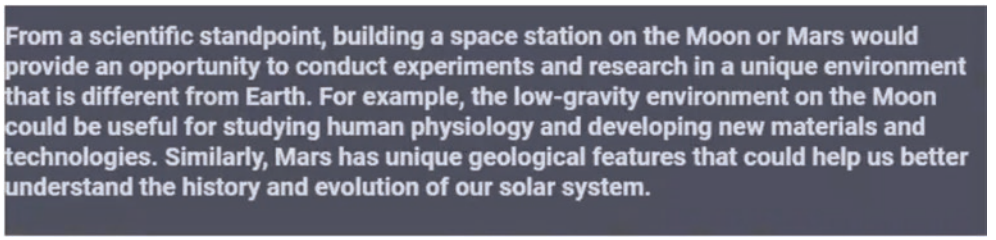


Figure 3. ChatGPT response in condition 2

She then went back to her essay and added a sentence (Figure 4) which appears to make use of the idea expressed in Figure 3 (*starting midway through the paragraph: most of the scientists…*).

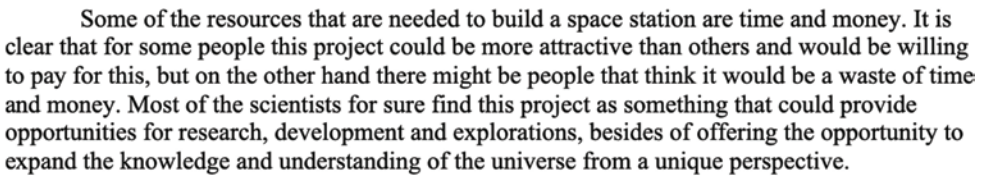

Some of the resources that are needed to build a space station are time and money. It is clear that for some people this project could be more attractive than others and would be willing to pay for this, but on the other hand there might be people that think it would be a waste of time and money. Most of the scientists for sure find this project as something that could provide opportunities for research, development and explorations, besides of offering the opportunity to expand the knowledge and understanding of the universe from a unique perspective.

Figure 4. Part of participant 16's essay

In summary, the dominant cluster of micro-processes which came about in condition 2 involved participants generating ChatGPT responses before writing their own as they went back and forth. They borrowed ideas and language from ChatGPT responses in the process.

Unlike the relative uniformity of condition 2 micro-process clusters (note that in keeping with the instructions every participant followed the same linear path in condition 2 as can be seen in Figure 2), condition 3 gave rise to a range, an expected finding considering the latitude the participants were given in deciding how to engage with ChatGPT. Notably, some participants' micro-actions were similar to the instructions in condition 2 as can be seen in Figure 5. They generated one or more responses and composed their own essays using them as examples. The only difference is that no participant generated three responses. Those who chose to follow writing condition 2 limited themselves to one or two generated ChatGPT essay.

This common cluster notwithstanding, the analysis brought into view another cluster of micro-actions the participants engaged in during the third writing condition which was absent in condition 2. The cluster consisted of a set of micro-actions and involved inputting prompts to ChatGPT. This cluster can be seen in Figure 6.

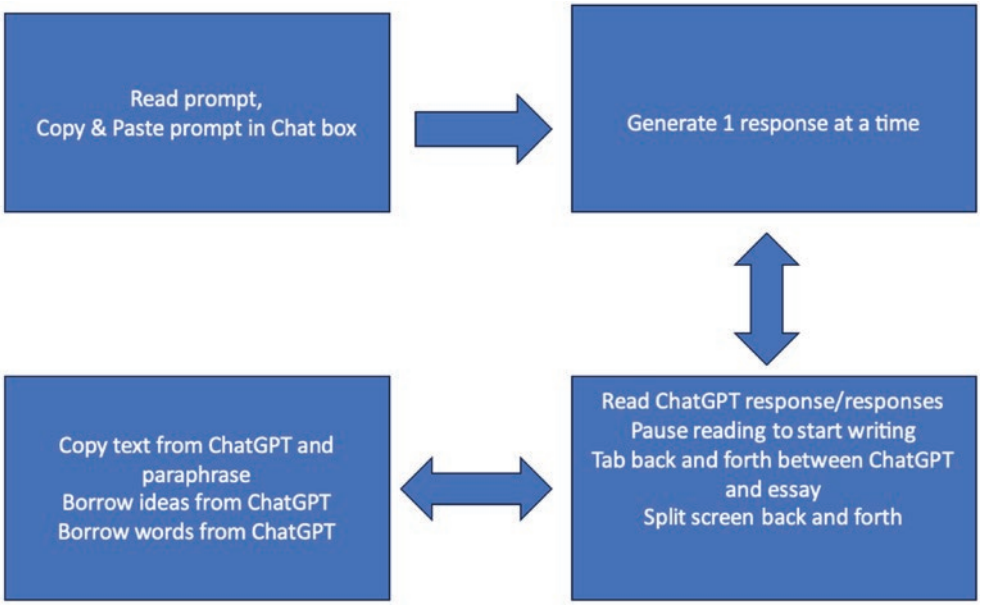


Figure 5. First cluster of micro-processes in condition 3

After reading the writing prompt, the participants began writing. The writing process, however, was interspersed with inquiries and requests. The first micro-action consisted of inquiries and text elicitations (ITE). We define them as either questions posed to ChatGPT or prompts designed to produce texts from ChatGPT. There were two kinds of ITEs: language and content. ITEs made up the majority of this cluster of actions and were evidenced in several participants' screen-recordings.

Figure 7 is an example of a content-related ITE. The participant asked for pros and cons of being best friends with one's children. Note that the question is different from the writing prompt (included in the appendix). The following are further examples of content-related ITEs.

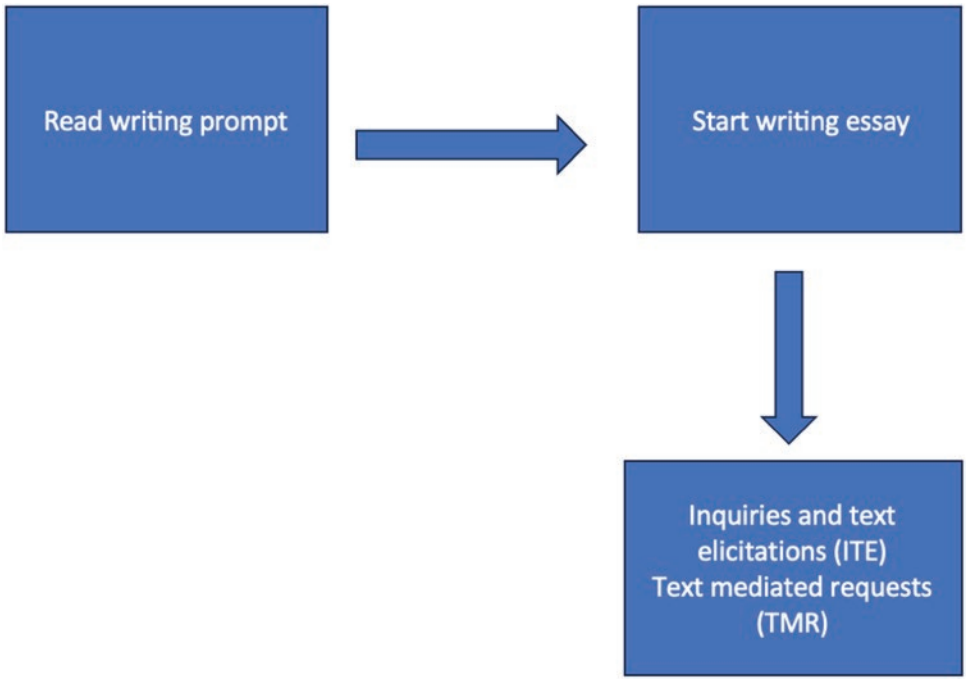


Figure 6. Second cluster of micro-processes in condition 3

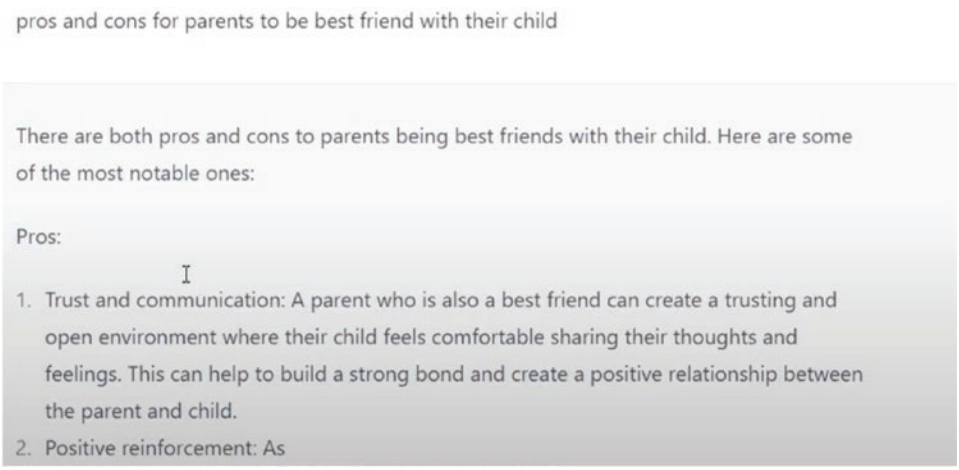


Figure 7. Content-related inquiries. Top part is participant inquiry and the lower part is ChatGPT's response

- "Is it worth it watching TV for long hours?"
- "Gentle parenting what is it"
- "is there a research that says that kids who were raised with gentle parenting are healthier?"
- "is puberty the hardest stage of growing up"
- "why should a parents not be a child's best friend completely?"

Along with content-related ITEs, some participants engaged in language-related ITEs. As the name suggests, unlike content inquiries, they concerned language. Figure 8 is an illustration of such an ITE.

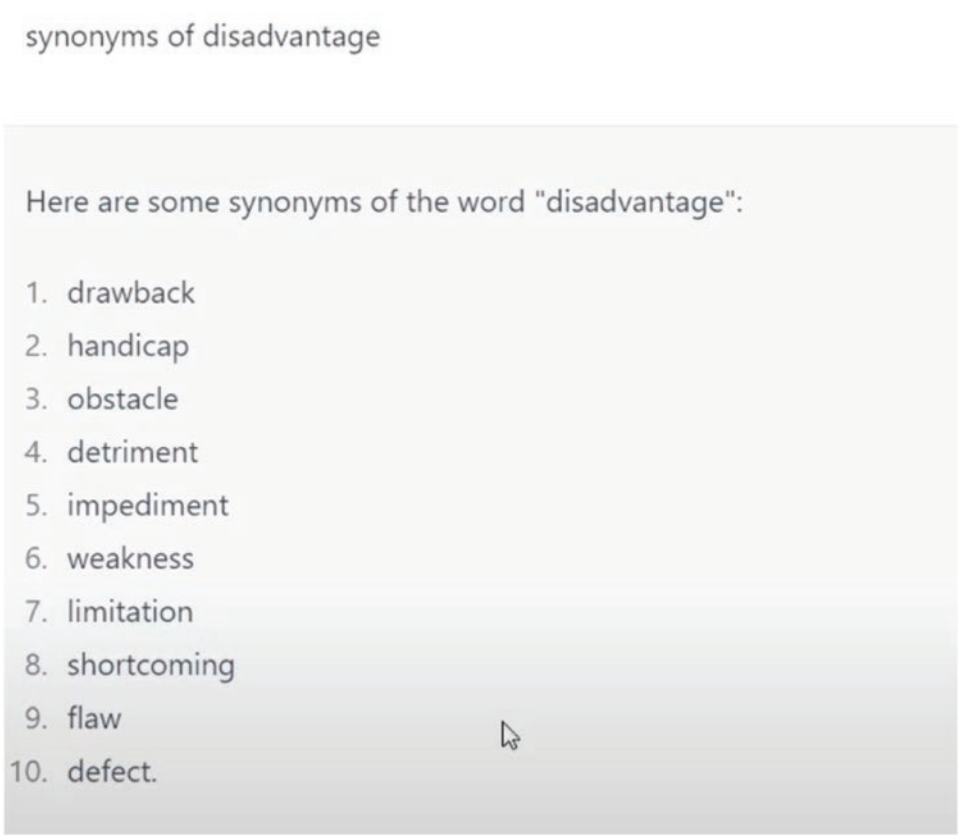


Figure 8. Language-related ITE. Top part is participant inquiry and the lower part is ChatGPT's response

These were not as frequent as content-related inquiries and only two participants' data included them.

The second micro-action comprised text-mediated requests (TMR). We define them as requests that ChatGPT perform an action on a user-provided text, hence text-mediated. They differ from inquiries in that they were not questions on either content or language. TMRs were a less common micro-process than ITEs. Figure 9 showcases a TMR.

The participant requested that ChatGPT check the paragraph. Although the request was ambiguous, not specifying what she expected ChatGPT to check, ChatGPT produced a response, focusing on the structure, which the participant took into account in revising her paragraph.

Figure 10 demonstrates another example of the same micro-action. The participant asked ChatGPT to paraphrase her text. The text was a paragraph that ChatGPT had produced in response to her ITE, asking for "the disadvantages of building a space station on moon or mars". She then took two sentences from the paragraph (Figure 10) and paraphrased them in her own essay. Figure 11 illustrates part of another TMR micro-process which began when the participant pasted her essay in ChatGPT. She then asked "what else should I add in this passage?"

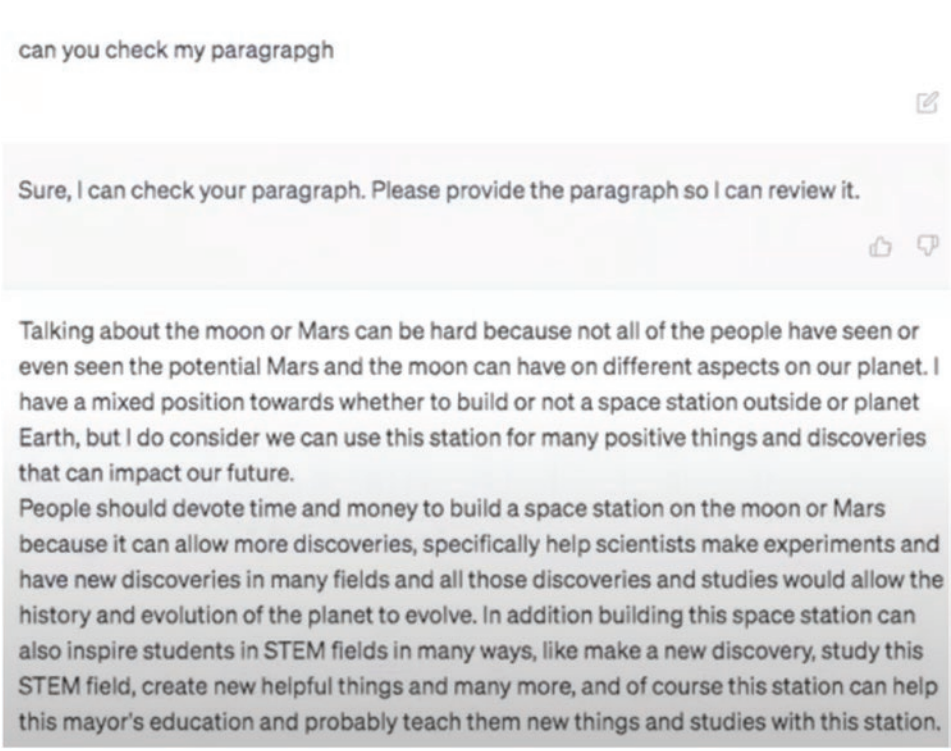


Figure 9. Text-mediated request. Top part is participant inquiry, middle part is ChatGPT's response and the lower box is the participants' paragraph in response to ChatGPT

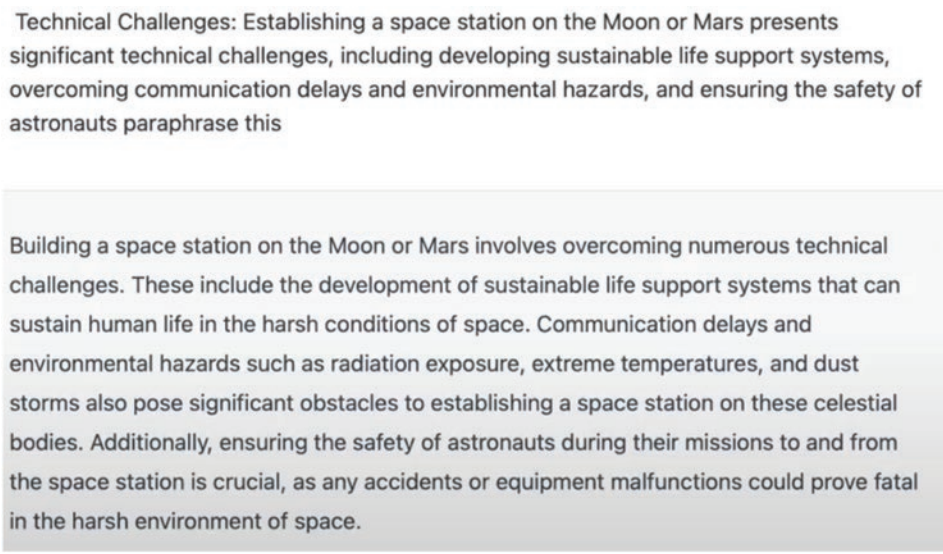


Figure 10. Text-mediated request. Top part is participant inquiry and the lower part is ChatGPT's response

In another instance of TMR, another participant copied her essay into ChatGPT and requested a word count. In addition to these two micro-processes, the analysis revealed a category of prompts which served an important function in participants' use of ChatGPT. While they are not micro-processes, they

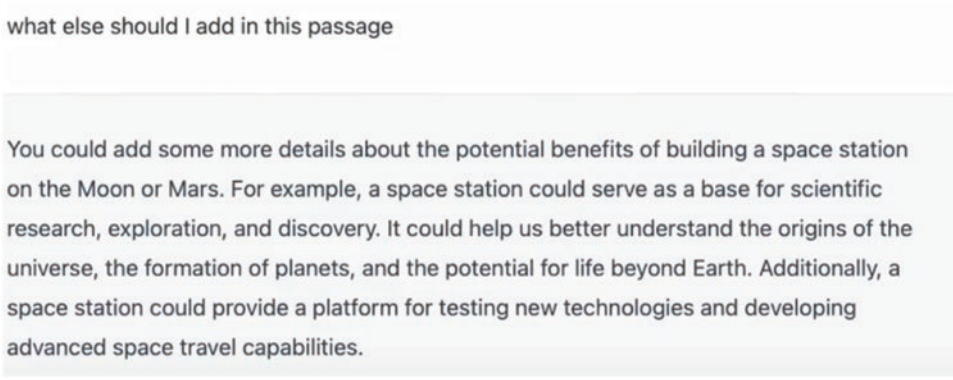


Figure 11. Text-mediated request. Top part is participant inquiry and the lower part is ChatGPT's response

were at play in the participants' micro-processes. We demonstrate them in the next section.

In summary, writing condition 3 gave rise to two sets of micro-processes. Three participants followed the first set of micro-processes (Figure 5) and three the second set (Figure 6). Six others merged the two. That is, in writing condition. Almost a quarter of the participants engaged in the same micro-processes as condition 2 while the rest either used a combination of the first micro-processes and new processes or engaged in completely new processes as they went about writing in condition 3.

The metapragmatics of prompt engineering

Across all categories of micro-processes participants used a class of words to tailor ChatGPT responses to best match their expectations. We term these words metapragmatic framers. They can be classified under discussions of prompt engineering and refer to parts of prompts which reflected the participants' awareness of language, context and its communicative functions. We define these elements as specific uses of language within prompts submitted to ChatGPT that serve to refine or direct the system's responses in precise language-aware ways. Importantly, these linguistic choices arise from and reveal participants' conscious understanding of how language functions and how it can be carefully calibrated. More specifically, they function as *linguistic labels*, that is metalinguistic cues embedded in prompts that frame the expected nature of GAI's response. These labels pertain to aspects of discourse, genre, register, rhetorical stance or other dimensions of language signaling to the model how the user intends the response to be shaped. As such, metapragmatic framers are not limited to single words but could include entire phrases or even sentences. While this practice intersects with the broader field of *prompt engineering* (see Giray, 2023; White et al., 2023), what we are describing is a narrower and more focused category of specific relevance to language education. This category is characterized by users' manifested awareness of language as a tool and their strategic maneuvers to guide GAI behavior (see Dynal, 2023, For a more detailed discussion of such metalinguistic practices in user prompts).

Metapragmatic framers are worth considering here because, despite their role in shaping ChatGPT responses, their use was patchy, varying from participant to participant. It is worth noting that not all prompts result from users' language awareness. The prompt "use academic language" contains metapragmatic framing in a way which the prompt "what is the best restaurant in California" does not. It is important to point out that metapragmatic framers include language-related ITEs but are a broader class of prompts. Metapragmatic framers appeared across both ITEs and TMRs.

Turning to the data, consider, for example, the term "balances" and "CLEAR" in the prompt in Figure 12 (Give an essay response which balances both the perspective in a CLEAR manner between 400–600 words).

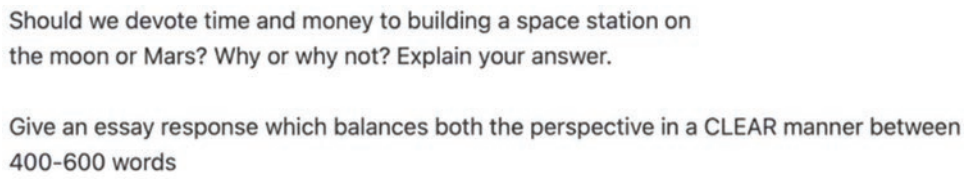


Figure 12. Metapragmatic framer (participant input)

The idea of balancing both perspectives has a metapragmatic function here, labeling the kind of discourse the participant expects. So is the word "clear", written in caps in the prompt presumably to underscore the importance of clarity for the participant. These terms are, in essence, tools to fashion the response essay through the specificity of such labels. Metapragmatic framers constitute specific categories of discourse, stemming from participants' awareness of language and context which serve as means of giving direction to GAI. Herein lies their importance.

Another illustration is the word "subtopic" in the prompt "give me more subtopic ideas for the essay". The word "subtopic" is a category of language, in particular in the discourse of writing education. The use of the term signals the participant's awareness. It is indeed the key way ChatGPT responses could be attuned to writers' rhetorical goals.

Discussion and conclusion

We set out to study how ChatGPT mediated ESL participants' writing microprocesses, the tool's effect on their essays, and their perceptions of it. In this section we present a summary of the findings, followed by a discussion and pedagogical implications before concluding with limitations and future directions.

No statistical differences were observed across the three conditions, despite most participants expressing a preference for the ChatGPT-assisted ones (Conditions 2 and 3). Participants found ChatGPT helpful for generating ideas and streamlining their writing, appreciating its convenience and support. However, some criticized its "robotic" tone, reflecting mixed views. While

participants valued ChatGPT, quantitative measures of writing quality did not align with these perceptions. Reporting non-significant findings is important to counteract biases toward positive results (Laitin et al., 2021), particularly with technologies like GAI which are often surrounded by hype about educational benefits.

The study examined technological mediation in L2 writing through micro-processes as the main site where tools like ChatGPT shape writing outcomes. ChatGPT became integrated into participants' micro-processes in Conditions 2 and 3. Condition 2 produced a relatively linear sequence of actions, while Condition 3 revealed two distinct clusters. Some participants alternated between ChatGPT and their own essays, borrowing ideas and phrasing; others engaged in more interactive actions, such as inquiry and text elicitation (ITE) or text-mediated requests (TMR). ITEs involved prompting ChatGPT for ideas or language, while TMRs involved asking ChatGPT to modify participants' own text.

Within these processes, we identified metapragmatic framers: prompt elements that shape ChatGPT's responses through discourse awareness (e.g., "a balanced perspective," "subtopics"). Though few were observed, their scarcity is revealing. Without mastery of such framers, ESL writers may struggle to guide ChatGPT effectively and remain limited to generic outputs. Pedagogically, language education should highlight these framers, encouraging students to experiment with them and analyze their effects on AI-generated text.

Our findings contribute to the growing literature on ChatGPT and ESL writing. Unlike several earlier studies (e.g., Yan, 2023), we found no significant performance differences, underscoring the need to publish neutral or negative results to counter industry-driven optimism. More striking were our insights into technologically mediated micro-processes. Previous studies reported actions like brainstorming, revising, or summarizing (Su, Lin & Lai, 2023; Wang, 2025; Woo et al., 2023; Zhao, Cox & Cai, 2024), but our analysis revealed broader categories (ITE and TMR) captured directly through screencasts rather than retrospection. These processes parallel findings from Woo et al. (2023) and Levine and Beck (2024), suggesting a consistent distinction between student-initiated inquiries and AI-modified text actions.

ITE and TMR also align with Hayes's (2012) model of writing: both occur within the task environment where AI functions as a collaborator, either generating ideas or revising text. This highlights how digital tools now mediate core elements of writing, extending beyond the writer's internal cognition. While prompt engineering has been widely discussed, metapragmatic framers have received little attention. Mollick (2024) illustrates, prompts embedding discourse cues (e.g., "speak in a dreamy but direct voice") shape AI output profoundly. Levine and Beck (2024) similarly note that generative AI enhances metalevel writing awareness. Such framers deserve focus in pedagogy, as they foster language awareness and discourse sensitivity, qualities essential for ESL learners.

Beyond addressing the specific research questions, the findings invite broader reflection on writing as a mediated activity in the age of generative

artificial intelligence (GAI). Grounded in a theoretical framework of mediation, this study sought to examine the effects of GAI on writing outcomes but it is worthwhile to reflect on how interaction with GAI reshapes the writing process itself. As GAI becomes an increasingly commonplace writing tool rather than a novel technology, it is important to consider how its routine integration transforms the nature of writing. The findings suggest that writing mediated by GAI cannot be fully understood through existing models of writing processes alone. Instead, they point toward the emergence of new forms of interaction that require a reconceptualization of the micro-processes that constitute writing.

The screen-recording analysis provides empirical evidence for this reconceptualization by revealing micro-processes that extend beyond those identified in previous writing research. In particular, the emergence of ITE and TMR, together with the strategic use of metapragmatic framers, illustrates how writers engage in new forms of meaning-making when interacting with GAI. Rather than functioning as a passive tool, GAI operates as a semi-responsive discourse partner that reorganizes writing at the micro-level. Writers can interrupt the act of composing to pose questions, request alternatives, seek clarification, or refine ideas through interaction with the AI, introducing collaborative practices that reshape the dynamics of writing. As illustrated by the participants in this study, the effectiveness of these interactions depends not only on the AI's responses but also on the writers' ability to formulate productive metapragmatic framers that guide the interaction. Consequently, writing with GAI involves developing new communicative competencies that extend beyond traditional composing skills and reflect an evolving understanding of writing as a dialogic, mediated process.

The findings present other questions too in addition to changes in the micro-processes. Specifically, the mismatch between participants' positive perceptions and the absence of measurable performance gains raises important questions about how writing quality is conceptualized and assessed. It is possible that traditional evaluation metrics fail to capture more subtle effects of AI-assisted writing, such as reduced cognitive load, increased confidence, or greater willingness to engage in revision. On the other hand, reliance on ChatGPT may lead to reduced linguistic engagement, with learners delegating key aspects of idea development or language formulation to the tool. This could result in surface-level fluency without deeper processing of language, potentially limiting long-term development. Considering these process-related dimensions, ChatGPT's role may be less about directly improving final products and more about reshaping the writing experience itself. This suggests a need for more nuanced assessment frameworks that account for process-oriented gains alongside product-based outcomes, particularly in L2 contexts.

The analysis of the observed micro-processes revealed variability in participants' engagement with ChatGPT, indicating differing levels of strategic competence, particularly in their use of metapragmatic framers in prompts. Some participants demonstrated an emerging awareness of how to guide the

model which resulted in more tailored and relevant outputs. The uneven use highlights a critical pedagogical gap: without explicit instruction, many learners may not develop the awareness needed to exploit these affordances. Consequently, pedagogical approaches should move beyond simply allowing or restricting AI use, toward explicitly teaching students how to construct context-rich prompts, evaluate AI outputs in relation to rhetorical goals, and iteratively refine both. Through guided practice and reflection, learners can begin to appropriate these strategies, transitioning from passive recipients of generated text to more deliberate and context-sensitive co-constructors of writing.

ChatGPT can be leveraged to support idea generation, vocabulary expansion, and essay organization. Educators can design activities involving AI-assisted brainstorming, outlining, or feedback to promote engagement and reflection on writing micro-processes. However, the perception of AI-generated text as mechanical underlines the need for critical literacy as students should evaluate and refine AI output to preserve their own voice and stylistic nuance. Assignments comparing AI-generated and self-written texts can cultivate this awareness.

Additionally, the absence of statistically significant differences in writing outcomes across conditions suggests that simply integrating ChatGPT may not automatically improve writing quality. Therefore, pedagogical approaches should shift from product-oriented assessment to process-oriented instruction. Teachers can explicitly model how to use AI as a cognitive tool rather than a shortcut, for example, guiding students to iteratively prompt, evaluate, and revise AI-generated suggestions. Incorporating think-aloud protocols, reflective journals, or process logs can help learners become more aware of their writing strategies and how AI influences their decision-making. This aligns with fostering metacognitive skills, enabling students to consciously regulate their writing processes when interacting with AI tools.

The identification of distinct micro-process clusters in GAI-asssited writing highlights the need to explicitly teach effective AI interaction strategies as part of digital writing literacy. Instruction can include the metapragmatics of prompt engineering, evaluating relevance and accuracy, and integrating AI outputs with personal knowledge. Classroom practices might include staged writing tasks where AI use is scaffolded or restricted at different phases (e.g., allowed for brainstorming but not drafting), encouraging students to develop independent proficiency. Ultimately, integrating ChatGPT into ESL pedagogy should aim not only to enhance linguistic performance but also to cultivate critical, and ethically aware writers in AI-mediated environments.

Limitations and conclusion

The findings need to be interpreted with caution as the study is not without its limitations. The study was based on a relatively small pool of participants. Since only eleven participants were included in the repeated-measures ANOVA, we cannot conclude that ChatGPT use has no effect on writing quality but that no statistically detectable differences were found in this sample.

Further, although the experimental conditions allow us to examine the use of GAI, the configuration of the two ChatGPT-mediated conditions is only a limited way to engage with GAI. These limitations point to directions for future research. Larger participant samples and varied settings are needed to understand ChatGPT's role in writing. Future work should also examine AI-assisted micro-processes in authentic, independent writing situations beyond experimental settings.

One other limitation of this study is that the data were collected in May 2023, during an early stage of widespread adoption of generative AI in education. Since then, ChatGPT and other large language models have undergone substantial updates that may influence the quality of generated responses and the ways in which users interact with these tools. Consequently, the findings should be interpreted within the technological context in which the study was conducted and should not be assumed to generalize directly to newer AI models or future versions.

In addition to the evolving nature of AI technology, the study design presents another limitation related to the sequencing of the experimental conditions. Although the writing prompts were counterbalanced across conditions, the order of the experimental conditions was fixed rather than counterbalanced. Consequently, potential order effects, such as practice, increased familiarity with the writing task, or fatigue, cannot be ruled out. Future studies should counterbalance the order of the experimental conditions to isolate the effects of the intervention more effectively.

Nevertheless, the study remains valuable because it provides empirical evidence of students' writing micro-processes which is needed to appreciate how students put GAI to use in actual practice beyond what they say. Future research should extend this work using more recent AI models and larger samples to examine whether these patterns persist as the technology evolves.

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Appendix

Writing condition instructions

Condition 1
Instructions: write an essay in response to the following questions. You should write without using any online resources. Your response should be between 400–600 words. You have 40 minutes.

Condition 2
Instructions: use chat GPT to generate three responses for the following question, read them carefully and then write your own essay. You can use the generated responses to get ideas for your own essay. The final response should be yours although you can certainly use the ChatGPT responses to help you. Your response should be between 400–600 words. You have 40 minutes.

Condition 3
Use ChatGPT in any way you see fit to write your essay in answer to the question below. You can use it to plan, to get language help, to have better ideas for your own essay, to manipulate your own response or in any other way you see fit.

You can interact with it to get better responses
You can type in keywords and generate ideas
Ask it to revise parts of its response
Give it more specific prompts in line with your expectations

The only requirement is to write your own response and not copy the entirety of the ChatGPT answers but you can certainly use parts of it as you see fit and integrate it into your answer. Your response should be between 400–600 words. You have 40 minutes.