

ARTICLE

## Investigating the Effect of Language Anxiety on Writing Fluency and Writing Accuracy

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### ABSTRACT

Writing in a second language is a demanding task for many student writers. Although the relationship between writing anxiety and written performance is well-documented, few studies have explored this connection from a process-oriented perspective. The present study investigates the relationship between writing anxiety, writing fluency, and writing accuracy, and further examines how anxiety relates to writing fluency. To this end, we analyzed the writing processes of 120 Vietnamese undergraduate students who were asked to write an email in response to a request. Participants also completed the Second Language Writing Anxiety Inventory, which assessed their perceived anxiety in various aspects of the writing process. Their composing activity was recorded using Inputlog, a keystroke logging tool that captures keyboard activity, mouse movements, window switches, and other computer-based actions. Results from confirmatory factor analysis and structural equation modeling revealed that writing fluency, but not writing anxiety, was negatively associated with writing accuracy. Specifically, students who wrote fewer characters per minute and paused more frequently tended to make fewer grammatical and lexical errors. Additionally, writing anxiety showed no significant relationship with writing fluency. These findings offer important educational implications and highlight the value of examining the writing process through keystroke logging. We encourage future research to further explore the nuanced relationships between writing anxiety and the dynamics of second language writing.

**Keywords:** Second Language Writing Anxiety; Writing Fluency; Keystroke Logging

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# 1. Introduction

Writing, regardless of genre, is both a cognitively and socially demanding activity. It requires substantial cognitive resources, as writers must manage a range of lower-level linguistic skills such as vocabulary, spelling, syntax, and grammar, alongside higher-order thinking skills like discourse planning and idea organization. At the same time, effective written communication demands more than just sentence construction; writers must also attend to the social dimensions of language and consider contextual appropriateness when making lexical and stylistic choices. Flower and Hayes (1980) captured this complexity by likening the writer to “a busy switchboard operator trying to juggle several demands on her attention and constraints on what she can do”<sup>[1]</sup>, a metaphor that vividly illustrates the multifaceted nature of the writing process. Given these challenges, writing is a cognitively and socially intensive task, even for native speakers<sup>[2]</sup>. For second or foreign language writers, the demands are often even greater, making the writing process considerably more difficult.

Writing difficulties can arise from a variety of sources, including limited working memory capacity<sup>[3]</sup>, writing apprehension<sup>[4]</sup>, and low self-efficacy<sup>[5]</sup>. Numerous studies have demonstrated that deficits in working memory can result in lower-quality texts and a more fragmented writing process<sup>[6]</sup>. Beyond cognitive constraints, second language (L2) writing challenges may also stem from affective factors such as writing anxiety. Because L2 writers must exert greater cognitive effort and typically write less fluently in their non-native language, which they have not yet mastered to the same extent as their first language, the writing process can provoke heightened anxiety<sup>[7]</sup>.

In contrast to the relatively robust body of research on working memory and writing performance, studies examining the role of affective factors, particularly anxiety, in L2 writing remain limited. Existing research has consistently found significant negative correlations between writing anxiety and writing performance in both first language (L1) contexts and L2 contexts<sup>[4,7–11]</sup>. However, these studies have largely adopted a product-oriented approach, focusing primarily on the features of the final written texts. Very few studies have investigated how writing anxiety may interfere with the writing process itself from a

process-oriented perspective.

Given these gaps in the literature, the present study aims to examine whether, and to what extent, language anxiety influences L2 writers’ writing processes and performance. Specifically, we employed the Second Language Writing Anxiety Inventory (SLWAI) to measure the anxiety experienced by our participants when writing in English<sup>[12]</sup>. To gain insight into the writing process, we used keystroke logging technology, specifically Inputlog, which allowed us to capture keyboard activity, mouse movements, and other computer-based interactions during the writing task. Writing accuracy was assessed using the ratio of error-free T-units to the total number of T-units in the final texts. Before presenting our methodology and findings in detail, we first review the empirical literature linking language anxiety to L2 writing performance.

## 1.1. Anxiety and Second Language Writing

Previous studies have provided compelling evidence that writing anxiety is a distinct form of anxiety, separate from general classroom anxiety<sup>[8,12–14]</sup>. Writing anxiety refers to negative emotional responses, such as worry, fear, or tension that can disrupt various aspects of the writing process and, ultimately, compromise the quality of the written product<sup>[15]</sup>. In second language (L2) research, however, writing anxiety has not received sufficient attention, in part due to the prevailing belief that speaking is the most anxiety-inducing of the four language skills (i.e., listening, speaking, reading, and writing) for L2 learners<sup>[15]</sup>. As a result, much of the existing research has concentrated on the relationship between anxiety and learners’ oral performance<sup>[16–20]</sup>. Nevertheless, writing, given its cognitive and social complexity, can be just as anxiety-inducing as speaking or any other language skill<sup>[21]</sup>. The demands of writing in a second language may cause learners to experience increasing levels of distress over time, which can lead to frustration or even aversion toward the writing process<sup>[22]</sup>.

In discussions of writing anxiety, researchers often consider learners’ attitudes and behaviors in the context of second language (L2) learning. Cheng (2002) identified three distinct types of writing anxiety: (1) cognitive anxiety, which involves worry about evaluation and negative outcomes that disrupt the thinking process; (2) somatic

anxiety, which refers to the physiological symptoms of anxiety, such as tension and nervousness; and (3) avoidance behavior, also known as “flight anxiety,” in which individuals attempt to avoid anxiety-inducing writing situations altogether<sup>[14]</sup>. Building on this framework, Cheng (2004) developed and validated the Second Language Writing Anxiety Inventory (SLWAI)<sup>[12]</sup>, a three-dimensional measure assessing L2 writing anxiety across these subscales: Cognitive Anxiety, Somatic Anxiety, and Avoidance Behavior. Although the effect of writing anxiety has been extensively studied in L1 writing<sup>[4,8,9]</sup>, fewer studies have investigated the relation between anxiety and second language writing. Overall, these studies have yielded consistent results regarding the negative effect of writing apprehension on the writing process, performance, and quality<sup>[4,12,23–26]</sup>. The typical finding is that writers with higher levels of apprehension tend to be weaker writers and produce written texts of poorer quality<sup>[7,10,27]</sup>.

This inventory has since been widely used in empirical studies to examine the detrimental effects of L2 writing anxiety on writing performance. However, because anxiety may first manifest during the writing process itself before it impacts the final written product, focusing solely on writing outcomes may not provide a complete picture. For instance, an L2 writer may experience heightened anxiety while composing when they lack the vocabulary or grammatical knowledge needed to express an idea. This can lead to disorganized thoughts, increased stress, and errors in language use, ultimately resulting in a lower-quality text and poorer performance. Therefore, adopting a process-tracing approach allows researchers to observe how writing anxiety disrupts the writing process and, in turn, how these disruptions contribute to writing difficulties. Such an approach can offer more nuanced insights into the relationship between anxiety and writing performance in L2 contexts.

Previous research has shown that writing experiences significantly influence levels of writing apprehension. Learners who engage in writing more frequently tend to develop greater confidence and report lower levels of anxiety<sup>[28–30]</sup>. In contrast, individuals with high writing anxiety often perceive writing as a daunting task and are more likely to avoid situations that require writing<sup>[8]</sup>. Similarly, students who have had negative writing experiences, such

as receiving critical feedback from teachers or peers, are more prone to anxiety and tend to avoid participating in writing activities<sup>[31]</sup>. These findings suggest that L2 writers with lower levels of writing apprehension are generally more at ease with writing tasks and are likely to write more fluently.

## 1.2. Fluency Through the Writing Process

Compared to speaking fluency, writing fluency has received relatively limited attention in second language (L2) research<sup>[32,33]</sup>. Traditionally, writing fluency has been examined using a product-based approach, emphasizing measurable aspects of the final text such as length, average sentence length, or readability<sup>[34]</sup>. However, with the development of keystroke logging technology, researchers have increasingly adopted a process-oriented perspective that captures the dynamic and cognitive nature of writing as it unfolds<sup>[35–37]</sup>. This shift toward process-tracing methodologies is driven by two main factors. First, keystroke logging software enables the unobtrusive collection of real-time data on writers’ behaviors, offering a window into the temporal and cognitive aspects of writing<sup>[38]</sup>. Second, an expanding body of research has demonstrated that writing fluency, defined by smooth and efficient cognitive and motor execution during writing, is associated with higher-quality written products and improved educational outcomes<sup>[36,39,40]</sup>. In general, writers who exhibit greater fluency during the composing process tend to produce texts of higher quality<sup>[36]</sup>.

Writing fluency, however, is a complex and multifaceted construct that can manifest in various aspects of text production. As a result, it has been operationalized in diverse ways across previous studies<sup>[34]</sup>. Prior to the advent of keystroke logging technology, writing fluency was typically measured through product-based indicators, such as the total number of words in a written text<sup>[41–43]</sup>. With the introduction of keystroke logging as a non-intrusive method for capturing real-time writing behavior, researchers have been able to explore more nuanced, process-based dimensions of fluency. These include interkey transition times, pause durations and locations<sup>[43,44]</sup>, and the frequency and length of uninterrupted writing segments, commonly referred to as “bursts” - defined as strings of characters produced between pauses.

Due to the variety in how writing fluency has been conceptualized and measured, Van Waes and Leijten (2015) proposed a multidimensional framework<sup>[33]</sup>. According to this perspective, writing fluency cannot be adequately captured through a single metric but rather must be understood through multiple process measures, including production rate, pause behaviors, revision activity, and burst characteristics. Since the introduction of this framework, it has been widely adopted in writing research to provide a more comprehensive understanding of process-based fluency. **Table 1** summarizes the ways in which writing fluency has been operationalized in prior studies to date<sup>[33,45–53]</sup>.

As shown in **Table 1**, contemporary writing research

has conceptualized writing fluency as a multidimensional construct, yet there remains no consensus on how it should be assessed<sup>[35]</sup>. As a result, researchers must rely on a combination of indicators rather than a single metric to evaluate writing fluency<sup>[33]</sup>. Similarly, in order to examine the impact of writing anxiety on writing fluency, it is essential to analyze how various components of fluency, such as production rate, pause behavior, and revision patterns, are influenced by anxiety. This multidimensional approach allows for a more nuanced understanding of how writing anxiety disrupts different aspects of the writing process and how these disruptions may, in turn, compromise the accuracy of the final written product.

**Table 1.** Summary of Prior Studies on Components of Writing Fluency<sup>[33,45–53]</sup>.

Components	Studies	Conceptualization
Rate of production	Wolfe-Quintero (1998) <sup>[45]</sup>	A temporal phenomenon in which the writers produce a certain number of words and structures in a time constraint The mean number of words or characters produced in a duration of time The number of minutes participants needed to produce 100 words
	Chenoweth and Hayes (2001) <sup>[46]</sup>	
	Knoch et al. (2015) <sup>[47]</sup>	
	Spelman Miller et al. (2008) <sup>[48]</sup>	
	Chandler (2003) <sup>[49]</sup>	
Pausing behavior	Schilperoord (1996) <sup>[50]</sup> Wengelin (2002) <sup>[51]</sup>	The total number of pauses or the average number of pauses per minute
		The ratio of pause time over total writing time in the whole writing process
		Pause length (mean processing time of pauses)
		Location of pauses (i.e., within words, between words, or between sentences)
Revision	Spelman Miller et al. (2008) <sup>[48]</sup>	The total number of deletions or additions in the writing process The ratio between the length of the final text and the number of characters or words produced during the writing process
	Van Waes and Leijten (2015) <sup>[33]</sup>	
Bursts	Chenoweth & Hayes, 2001 <sup>[46]</sup>	The number of bursts
	Hayes & Chenoweth, 2007 <sup>[52]</sup>	The processing time of bursts
	Olive et al., 2009 <sup>[53]</sup>	The length of bursts (characters of bursts produced in a burst)

1.3. The Present Study

As highlighted in previous research, studies exploring the relationship between anxiety and the L2 writing process have been limited. However, the advent of keystroke logging tools, such as Scriptlog, CyWrite, Translog, and Inputlog, has allowed writing researchers to capture and analyze the writing process with greater precision. In this study, we utilize Inputlog to record the writing processes of pre-intermediate L2 English learners. Inputlog is a keystroke logging software known for its millisecond-level precision and has become a widely used tool in writing research due to its practicality, validity, and reliability<sup>[38]</sup>. Although Inputlog offers detailed analyses of the writing

process, it does not support inferences about the reasons behind the logged behaviors. For instance, while we can observe how often a student pauses, we cannot determine why they pause. Given this limitation, the current study focuses on examining the relationships among writing anxiety, writing fluency, and writing accuracy, rather than exploring potential causal links between them.

To assess the level of anxiety experienced by our L2 writers, we use the Second Language Writing Anxiety Inventory (SLWAI) developed and validated by Cheng and colleagues<sup>[12]</sup>. Regarding writing fluency, we examine four variables, each representing a distinct aspect of fluency: (1) the number of characters produced per minute (rate of production), (2) the ratio of pause time to active writing time

(pause behaviors), (3) the product-process ratio (revision), and (4) the number of P-bursts per minute (bursts). These four variables were chosen based on previous research indicating that they are the strongest predictors and most reliable indicators of writing fluency<sup>[33,54,55]</sup>. However, as noted by Baaijen et al. (2012) and Galbraith and Baaijen (2019)<sup>[54,55]</sup>, while keystroke logging offers a detailed record of the writing process in real time, the measures it generates—such as bursts, pauses, and revisions—do not always provide a clear interpretation of the underlying cognitive processes. For instance, pauses during writing can reflect either difficulty retrieving the appropriate words or phrases or challenges in planning the next part of the text. Moreover, given that our participants are inexperienced writers just beginning to produce texts in English, these four variables offer a practical means of capturing the relatively straightforward writing processes typical of beginner L2 writers.

The current study, therefore, aims to address the following research questions:

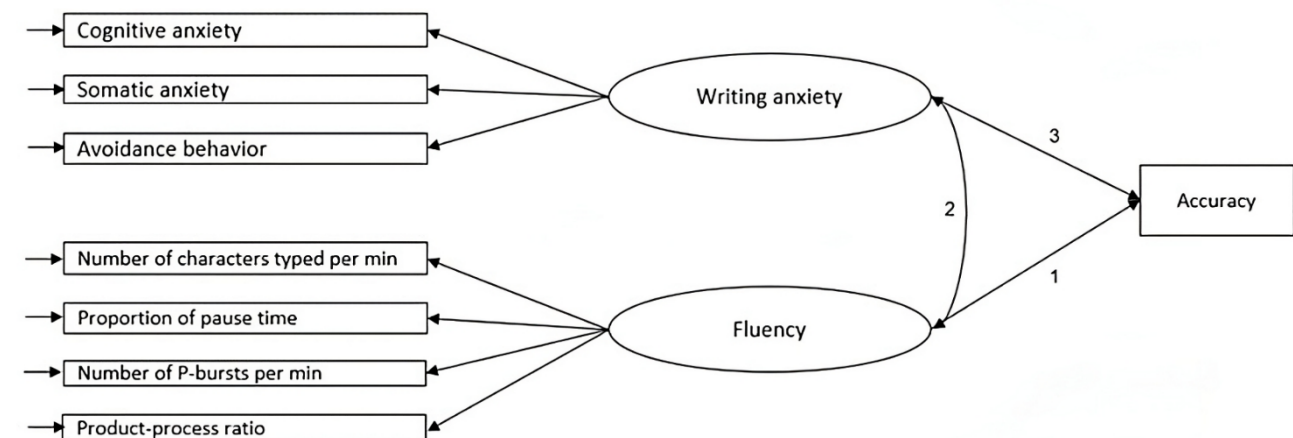
a) What is the relationship between writing anxiety, writing fluency, and writing accuracy among L2 writers?

b) To what extent is writing fluency associated with writing anxiety?

## 1.4. The Hypothesized Model

In this study, we selected four measures to assess writing fluency: 1) the number of words produced per minute, 2) the ratio of pause time to total process time, 3) the process-product ratio, and 4) the number of P-bursts per minute. To examine the impact of the three types of writing anxiety (i.e., cognitive anxiety, somatic anxiety, and avoidance behavior) on writing fluency and writing accuracy, we constructed a Structural Equation Modeling (SEM) model. Previous research has shown that more fluent writers tend to produce more accurate texts, which led us to hypothesize a path from fluency to writing accuracy (1). Additionally, as prior studies have demonstrated, writing anxiety can disrupt the writing process and ultimately affect the quality of the written product; thus, we proposed a path from writing anxiety to writing fluency (2) and another path from writing anxiety to writing accuracy (3). The proposed SEM model for this study is illustrated in

**Figure 1:**



**Figure 1.** The Proposed SEM Model Showing the Effect of Writing Anxiety and Writing Fluency on Accuracy, as Well as the Relation Between Writing Anxiety and Fluency.

## 2. Materials and Methods

In total, a cohort of 290 Vietnamese pre-intermediate EFL students (A2 level according to the Common European Framework of Reference for Languages) partici-

pated in the study. Due to data attrition, technical issues, incomplete responses, absences, withdrawals, and missing consent forms, the final sample was reduced to 120 participants (N = 120). The majority were first-year and second-year undergraduate students (Mean age: 19 years and 6

months, SD: 7 months) at a public university in Vietnam and were majoring in a wide range of majors, including finance, language studies, and technology. Prior to the start of term, the participants were required to take an English language proficiency test where their four language skills in English (listening, reading, writing, and speaking) and vocabulary and grammatical knowledge were assessed. The test consisted of 50 multiple-choice items and was timed for 45 minutes. This language test was essential as it provided benchmark scores for administrators to place the students into different classes appropriate for their level of English proficiency. Participants were placed at the same proficiency level based on their test results, although individual differences in language ability may still exist.

All the participants filled out a background ques-

tionnaire about their basic information (e.g., age, gender, the age at which they started to learn English, and their self-evaluation of their overall English-language abilities) before they did the writing tasks (**Table 2**). The self-evaluation of English language skills was designed to offer students an opportunity to self-assess their writing skills before engaging in the primary task of the study. This task also provided instructors and researchers with valuable insights into the participants' proficiency level. By doing so, the researchers were able to design writing tasks that were both appropriate and challenging for students. It is important to note that the self-assessment primarily serves as a reflective tool for both students and teachers, rather than a precise measure of students' actual language proficiency.

**Table 2.** Background Information of the Participants (N = 120).

Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	46	38.3
	Female	64	53.3
	Prefer not to say	10	8.3
Age of acquisition (English)	From 1–5 years of age	3	2.5
	From 5–13 years of age	51	42.5
	From 13–18 years of age	60	50.0
	From 18 years of and onward	6	5.0
Language abilities			
Overall	Poor	11	9.2
	Moderate	80	66.7
	Good	24	20.0
	Very good	3	2.5
	Proficient	2	1.7
Listening	Poor	27	22.5
	Moderate	70	58.3
	Good	18	15.0
	Very good	5	4.2
Speaking	Poor	28	23.3
	Moderate	66	55.0
	Good	22	18.3
	Very good	3	2.5
	Proficient	1	0.8
Reading	Poor	7	5.8
	Moderate	71	59.2
	Good	33	27.5
	Very good	8	6.7
	Proficient	1	0.8
Writing	Poor	31	25.8
	Moderate	61	50.8
	Good	26	21.7
	Very good	2	1.7

The rationale for using both the admission language test and the self-assessment was twofold. First, the self-assessment provided insight into learners' perceptions of their language abilities - an important factor when examining writing anxiety and processes, as self-perceived competence can significantly influence performance. Second, the standardized test offered a more empirically grounded basis for grouping participants and conducting comparative analyses.

All the participants provided their consent before starting the study. They were first presented with information on the objectives, procedures, potential risks, and benefits associated with the study. Participants were also informed of their rights to withdraw at any point without providing any reason or being penalized.

## 2.1. The Second Language Writing Anxiety Inventory

To assess participants' anxiety levels in writing, we employed Cheng's (2004) Second Language Writing Anxiety Inventory (SLWAI), a 22-item scale (see **Appendix A**)<sup>[12]</sup>. In its original validation, Cheng (2004) reported a Cronbach's alpha of 0.91, indicating high internal consistency<sup>[12]</sup>. The SLWAI has since been widely used to examine the relationship between second language writing anxiety and writing performance<sup>[56-58]</sup>. Those studies demonstrated that the measure was internally consistent across different educational contexts. For example, Mulyono et al. (2020) investigated 221 Indonesian students from secondary to university levels<sup>[56]</sup>, finding strong internal consistency with Cronbach's alpha value of 0.95. More recently, Kong et al. (2024) confirmed similar findings among 518 senior high school students in China<sup>[57]</sup>, reporting an overall Cronbach's alpha of 0.91, while Waked et al. (2024) provided further evidence of SLWAI's robust reliability with Cronbach's alphas over 0.8 when examining 857 Arabic-speaking Saudi Arabian university students<sup>[58]</sup>.

For this study, we adapted the original 5-point Likert scale (ranging from 1 = strongly disagree to 5 = strongly agree) to a 6-point frequency-based scale: (1) Always/most of the time, (2) Usually/in most cases, (3) Often/in some cases, (4) Sometimes/occasionally, (5) Rarely, and (6) Never. The questionnaire includes three subscales: Somatic Anxiety (items 2, 7, 9, 13, 15, 18, 23), Avoidance Behav-

ior (items 4, 6, 12, 14, 19, 22, 27), and Cognitive Anxiety (items 1, 3, 8, 10, 17, 21, 24, 26). Higher scores on both the subscales and the overall scale indicate greater levels of L2 writing anxiety. In our study, the modified SLWAI demonstrated acceptable reliability, with a Cronbach's alpha of 0.78.

## 2.2. Procedure

The second author of this paper conducted and supervised the data collection process. At the start of the study, she met with the participants at the beginning of the academic semester to thoroughly explain the study's aim, how it would be administered, and potential risks involved. All the participants understood and voluntarily signed the consent form to participate in the study. They also acknowledged that the data collected would remain confidential and be only used for research purposes. Within the following week, they were asked to complete the Second Language Writing Anxiety Inventory (SLWAI) at their convenience. Meanwhile, the researcher arranged the writing sessions for different groups at times that best accommodated the participants' availability and after they completed their questionnaires.

During each writing session, the researcher first instructed on installation and familiarized the participants with the Inputlog software. Then, she required the participants to switch off their mobile phones and put them away before they started writing. All participants had up to 40 minutes to finish their writing tasks and were allowed to use online dictionary websites or dictionary applications on their laptops to support their writing process. However, they could not use Google Translate to translate the entire text or secretly use their mobile phones to do so. The researcher excluded those who failed to comply with the requirements or declined further participation.

## 2.3. The Composition Task

Participants were presented with an email from a prospective buyer interested in purchasing a house and were instructed to compose a response addressing the buyer's request for a bargain price. They were asked to write as if they were privately selling their own home, incorporating at least two details about the house's location and provid-

ing one reason for either supporting or rejecting a price negotiation. The full writing prompt is available in **Appendix B**.

Responses were required to be 100 to 150 words long and completed within 40 minutes. To support their lexical development, participants were permitted to use online dictionaries and translation tools for vocabulary and phrase lookup. This allowance aimed to replicate an authentic writing environment and alleviate challenges related to limited language proficiency. Given that pre-intermediate learners are still refining their sentence construction skills, these digital aids were intended to reduce linguistic barriers and enhance their confidence under time constraints. This writing task simulated a customer inquiry scenario, assessing students' ability to craft a formal response that adhered to the appropriate style and register. We believe it provided a balanced challenge, engaging students in critical thinking while remaining feasible to complete within the allotted time.

## 2.4. Accuracy Ratio

To assess the accuracy of our L2 students' writing, we calculated the ratio of error-free T-units to the total number of T-units, as done by Zabihi (2018) <sup>[11]</sup>. According to Zabihi (2018) <sup>[11]</sup>, Wolfe-Quintero (1998) reviewed 42 measures of writing accuracy and found that this error-free T-unit ratio demonstrates high to moderate correlations with second language writing proficiency <sup>[45]</sup>. We included all types of errors in our analysis, such as syntactic errors (e.g., word order, incomplete sentences, and run-on sentences), lexical errors (e.g., word choice, use of articles, tense, and agreement), spelling errors, and punctuation errors. For example, if a student's email contains 13 T-units, 6 of which are error-free, the accuracy ratio is 0.46. Two raters assessed the data, and the inter-rater reliability was calculated at 0.98, indicating a high level of agreement. For the differences, the two assessors discussed and agreed on the final ratios.

## 2.5. Preparing Inputlog Data for Further Analysis

The keystroke logging data were processed using Inputlog version 8.0 for further analysis. To extract relevant

variables related to the writing process, we conducted the following analyses integrated in Inputlog (see Inputlog User's Manual; [www.inputlog.net](http://www.inputlog.net)):

**a) Summary analysis:** Provides an overview of the total process duration, text length, number of characters produced, and the distribution of pause and active writing time.

**b) Pause analysis:** Examines pause behavior at different text levels (within words, between words, phrases, sentences, and paragraphs) and across various time intervals.

As mentioned before, we perceive writing fluency as a multi-faceted concept and examine our students' writing process by using four variables: 1) the number of characters typed per minute (summary analysis), 2) the ratio of pausing time over active writing time (pause analysis), 3) the number of P-bursts produced per minute (pause analysis), and 4) the ratio between the length of the final text and the number of words produced throughout the writing process (summary analysis). We performed the summary and pause analyses on the students' process data to obtain information on the four variables of interest. We prepared the data for the next step. The next section provides an overview of students' writing processes in relation to their experienced anxiety and illustrates the connection between writing anxiety and writing accuracy. Any discrepancies were resolved through discussion between the two raters, who reached consensus on the final ratios.

## 3. Results

### 3.1. General Information on the Students' Writing Process and Anxiety Level in Writing

We conducted the final analyses on 120 log files (N = 120). Descriptive statistics and a correlation matrix were performed using SPSS (version 28.01.0). As outlined in the Method section, participants were given 40 minutes to write their email. On average, participants took approximately 42:32 minutes to complete the task. The students produced an average of 6.11 words per minute (SD = 4.65). A closer examination of the students' process data revealed that, on average, participants spent 17:24 minutes (SD = 9:13) writing in the main Word document (the email). While writing, students paused to consult a dictionary or

other external resources beyond the primary writing task. These non-writing intervals were categorized as “pause time.” On average, students paused for 25:08 minutes (SD = 16:23) during their writing process.

As we were interested in examining the relationship between language anxiety and writing fluency, and considering that writing fluency is a multidimensional concept, we focused on four key variables that are strong indicators of writing fluency: 1) the number of characters produced per minute, 2) the proportion of pause time, 3) the number of P-bursts produced per minute, and 4) the product-process ratio. In addition to the process-related variables, we also assessed anxiety levels, dividing them into three subscales: cognitive anxiety, somatic anxiety, and avoidance behavior. As described in the Materials and Methods section, anxiety was measured using a 6-point scale, which indicated the frequency of anxiety as follows: (1) Always/Most of the time, (2) Usually/In most cases, (3) Often/In some cases, (4) Sometimes/Occasionally, (5) Rarely, and (6) Never. To align with the scoring conventions of previous studies, we rearranged the scale so that it reflected the following: (1) Never, (2) Rarely, (3) Often/In some cases, (4) Sometimes/Occasionally, (5) Usually/In most cases, and (6) Always/Most of the time, ensuring that higher scores corresponded to higher levels of anxiety. The anxiety questionnaire included three subscales with a total of 22 items: 8 items for Cognitive Anxiety, 7 items for Somatic Anxiety, and 7 items for Avoidance Behavior. We calculated the sum of the scores for each subscale. **Table 3** provides an overview of the descriptive statistics for all the variables in the study, including anxiety scores, process-

related variables, and accuracy indices.

We conducted a normality test on all the anxiety-related and process-related variables. The results indicated that the four variables representing students’ writing processes were not normally distributed, suggesting the need for non-parametric tests in subsequent inferential analyses. **Table 4** presents Kendall’s correlation matrix for all the variables.

TCA = Cognitive Anxiety; SA = Somatic Anxiety; AB = Avoidance Behavior; OA = Overall Writing Anxiety; CPM = Characters Typed Per Minute; PPR = Product/Process Ratio; PPT = Proportion of Pause Time; PBPM = Number of P-bursts Per Minute; A = Accuracy

As shown in **Table 4**, the students’ scores on the various writing anxiety measures are significantly interrelated. For instance, students who scored higher on cognitive anxiety also exhibited higher levels of somatic anxiety and avoidance behavior, which contributed to an overall higher level of writing anxiety. Regarding the writing fluency variables, some are significantly correlated with each other. For example, students who produced more characters per minute tended to pause less often, resulting in a lower proportion of pause time. At the same time, these students also produced more bursts of writing per minute and demonstrated greater fluency throughout the task. However, the results revealed no strong correlations between writing anxiety measures and the fluency indicators. Additionally, text accuracy was positively correlated with the proportion of pause time but negatively correlated with the number of P-bursts produced per minute.

**Table 3.** Descriptive Statistics and Factor Loadings for Anxiety and Process-Related Variables.

Component/variable	M	SD	Max	Min	Range	CFA loading (Std. all)
Writing Anxiety						
1.Cognitive Anxiety	23.79	5.62	37.00	8.00	29.00	0.700
2.Somatic Anxiety	33.78	9.80	54.00	13.00	41.00	0.808
3.Avoidance Behavior	19.78	5.58	30.00	7.00	23.00	0.844
4.Overall Writing Anxiety	77.35	18.24	117.00	41.00	76.00	-
Writing fluency						
5.Characters typed per min	34.76	26.37	143.42	8.70	134.72	0.865
6.Product/process ratio	0.78	0.73	8.54	0.22	8.32	0.084
7.Proportion of pause time	0.54	0.17	0.84	0.18	0.66	-0.838
8. Number of P-bursts per min	3.58	1.25	9.29	1.57	7.72	0.581
Product						
9. Accuracy	0.43	0.26	1.00	0.00	1.00	-

**Table 4.** Kendall's Correlation Matrix for All the Variables.

	1	2	3	4	5	6	7	8	9
1.CA	1								
2.SA	0.428**	1							
3.AB	0.446**	0.533**	1						
4.OA	0.608**	0.791**	0.691**	1					
5.CPM	-0.045	0.060	-0.058	-0.052	1				
6. PPR	0.064	0.084	0.060	0.090	0.223**	1			
7. PPT	0.043	0.094	0.072	0.084	-0.497**	-0.129*	1		
8. PBPM	0.050	0.034	0.005	0.038	0.295**	0.248**	-0.402**	1	
9. A	-0.032	0.089	0.048	0.068	-0.070	0.098	0.205**	-0.126*	1

\*\* . Correlation is significant at the 0.01 level (2 tailed).

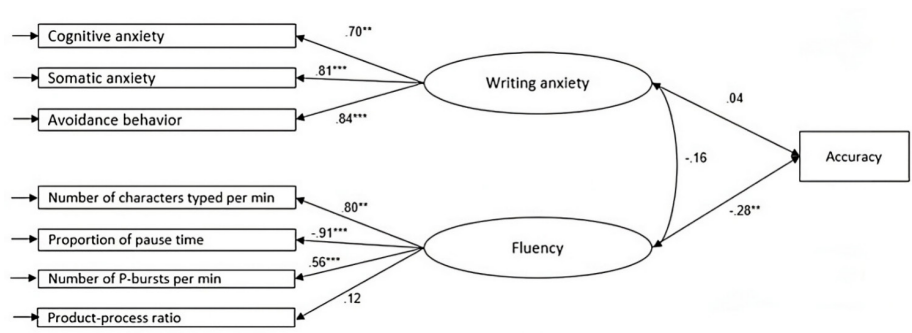
\*. Correlation is significant at the 0.05 level (2 tailed).

### 3.2. The Relation between Writing Anxiety and Writing Fluency and Accuracy

To assess the potential relationships between writing anxiety, writing fluency, and writing accuracy, we primarily employed Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM). These advanced analyses were conducted using R (version 4.1.0), offering flexibility for model modification and examination of model fit indices. First, we performed CFA to explore the relationships among latent variables and determine whether the observed variables (i.e., process data variables and anxiety measures) could be grouped into broader components (i.e., general writing anxiety and writing fluency). The CFA model included two components and seven variables (see **Figure 2**). We began with a chi-squared test to assess the difference between the observed and expected covariances. The p-value for the chi-squared test was .186, indicating no significant difference between the two covariances. Next, we examined the Comparative Fit Index (CFI),

which compares the resulting model to a baseline model (i.e., a model with no relationships). In the literature, a CFI score above .90, or even .95, is typically considered indicative of a good model <sup>[59]</sup>. Our CFI score of 0.984 suggests that our model fits the data well.

Additionally, we used the Root Mean Square Error of Approximation (RMSEA) to assess the discrepancy between the sample covariance matrix and the model covariance matrix. The literature suggests that an RMSEA value below 0.08 indicates a good fit, while values between 0.08 and 0.10 suggest a moderate fit <sup>[60]</sup>. Our RMSEA value was 0.053, indicating an excellent fit for our model and confirming an appropriate sample size. Finally, we incorporated writing accuracy into the analysis using Structural Equation Modeling (SEM), which allowed us to examine the relationship between writing accuracy and the two latent components. One component represented the fluency of students' writing processes, while the other captured the level of anxiety experienced by the students while composing their texts (see **Figure 2**).



**Figure 2.** The SEM Model Showing the Effect of Writing Anxiety and Writing Fluency on Accuracy and the Relationship Between Writing Anxiety and Fluency.

**Figure 2** illustrates that writing accuracy is significantly influenced by “Fluency,” with a path coefficient of  $-.28$ . This suggests that for every 1 standard deviation decrease in the standardized score for the “Fluency” component, the standardized accuracy score increases by  $.28$  standard deviations. In other words, students who demonstrated lower fluency in their writing process tended to produce texts with higher accuracy (i.e., making fewer mistakes related to grammar or vocabulary). **Table 5** presents the standardized parameter estimates for the final SEM model.

**Table 5.** Standardized Parameter Estimates of the Final SEM Model.

	Estimate	Std. all	sign.
Accuracy ~ Anxiety	0.003	0.043	0.660
Accuracy ~ Fluency	-0.003	-0.279	<b>0.004</b>
Anxiety ~ Fluency	-13.041	0.159	0.146

## 4. Discussion

This study explored the relationship between writing anxiety, writing fluency, and writing accuracy among L2 writers. In the following sections, we first summarize the key findings of the study and discuss them in relation to the existing literature on writing anxiety, fluency, and second language writing. We then highlight the theoretical, methodological, and educational implications of these findings. Finally, we acknowledge the limitations of the current study and propose directions for future research based on these limitations.

Based on the SEM model, we mapped out the potential relationships between writing anxiety and writing accuracy, as well as between writing fluency and writing accuracy. Additionally, we assessed the link between writing anxiety and fluency in the writing process of our L2 student writers. The results of this study revealed no significant relationship between writing anxiety and writing accuracy. Another key finding is that writing anxiety did not appear to significantly affect the fluency of the students during their writing process. Finally, we identified a relationship between writing fluency and writing accuracy: student writers who produced fewer characters per minute on average, paused more frequently, wrote in shorter bursts, and revised more often tended to produce texts of higher quality (i.e., fewer grammatical and lexical errors).

As mentioned in the Introduction, empirical research on writing anxiety using a process-oriented approach is relatively limited, which makes it difficult to directly compare and contrast our findings with existing literature. However, we can still assess how our findings complement or contradict previous studies, most of which have examined writing anxiety from a product-based perspective. A key finding in our study was that writing anxiety did not significantly affect writing performance. This result contradicts many previous studies, which found that writing anxiety negatively impacts writing performance<sup>[7,10,11,27,61,62]</sup>. The discrepancy in findings may be due to the fact that most of these previous studies involved upper-intermediate learners who were more advanced in writing proficiency. In contrast, our study focused on pre-intermediate learners whose writing proficiency was still developing. This difference in proficiency may explain why our participants, who were grappling with lower-order writing skills such as vocabulary and grammar, did not show the same negative impact of anxiety on writing performance. We argue that the relationship between writing anxiety and writing performance in our study was likely obscured by the lower proficiency level of our participants.

Secondly, we found that writing fluency is negatively related to writing performance. This is an intriguing finding as it both contradicts and supports previous studies. Some studies have suggested a positive effect of writing fluency on text quality. For instance, Mohsen (2021) found that more pauses and minimal word production resulted in lower-quality writing<sup>[63]</sup>. Similarly, Speltz and Chukharev-Hudilainen (2021) conducted a study where participants in the treatment group received automated real-time feedback to improve their fluency<sup>[40]</sup>. They explicitly encouraged fluency throughout the writing process, and students in this group produced higher-quality texts. However, it is important to note that these participants were native English speakers with advanced language proficiency. For more fluent writers, writing fluency might indicate better cognitive resources, greater lexical knowledge, or more developed grammatical skills. In the current study, however, the data suggest that lower writing fluency may be linked to higher writing accuracy. One possible explanation is that less advanced students who write more slowly might engage in more planning or self-monitoring during the writ-

ing process. Alternatively, frequent pauses could indicate the use of external resources, such as dictionaries or grammar-checking tools, which may enhance accuracy despite decreasing fluency. This finding underscores the need to interpret fluency measures within context, as slower writing does not necessarily reflect lower proficiency.

On the other hand, writing fluency does not always lead to higher-quality texts, as some studies have suggested a more strategic approach to fluency. For example, Baaijen et al. (2012) found that writers who paused more regularly at the sentence level produced shorter but better-formed bursts of text<sup>[55]</sup>. This indicates that the relationship between writing fluency and writing performance is not a simple, linear one. Based on our findings, we suggest that writing instructors should focus on helping students craft well-formed phrases and sentences in their writing process, especially for those who are still beginners in second language writing, rather than emphasizing fluency too early.

Finally, one of our primary goals was to examine the interaction between writing anxiety and writing fluency, as it is commonly believed that writers with high anxiety exhibit less fluent writing processes. However, in this study, we found no significant relationship between writing anxiety and writing fluency. While the connection between writing anxiety and text quality has been well established in the writing literature, research using a process-tracing approach to explore this relationship is much more limited, which made it difficult for us to compare our results with previous studies. One of the few studies examining how writing anxiety might influence the writing process is Sun et al. (2024)<sup>[64]</sup>, which employed a qualitative approach using semi-structured interviews to explore how writing anxiety was experienced by 18 Chinese EFL learners. However, this qualitative study could not provide detailed insights into the extent to which writing anxiety affects the writing process. Given the limited literature on this issue, we refrain from making further conclusions and encourage more process-oriented research to explore the link between writing anxiety and writing process characteristics. Although we did not find a relation between writing anxiety and writing performance, our study offers valuable implications, which we will discuss in the following sections, along with some limitations that may have impacted our

results.

The present study holds significant theoretical, methodological, and educational implications. Theoretically, we have identified specific process-related variables that describe writing fluency, aligning with Van Waes and Leijten's (2015) conceptualization of fluency as a multidimensional construct<sup>[33]</sup>. As indicated by the CFA results, we found that variables related to the rate of production and pausing behavior; more specifically, the number of characters produced per minute and the ratio of pausing time to total process time were more effective indicators of writing fluency than cognitive bursts or revision behaviors. Methodologically, our study demonstrates the value of using keystroke logging and process-related variables to investigate the relationship between affective factors and writing. Since writing is a complex skill that involves both cognitive and affective elements, traditional product-based approaches would not provide sufficient insights into how these factors influence writing performance.

For second language learning and teaching, we recommend that teachers and writing instructors prioritize accuracy over fluency, particularly when working with students in the early stages of language learning and writing development. Additionally, since we did not find a significant relationship between writing anxiety and performance in our study, one possible explanation is that our students were allowed to use online dictionaries and other resources during their writing tasks, which may have helped reduce any potential anxiety. Based on this, we suggest that instructors encourage the "strategic" use of external tools for students who are still developing their writing skills in a second language, as it may alleviate some of the stress or anxiety they experience during writing tasks.

From a pedagogical perspective, these results suggest that writing instructors should not assume that anxious students will inevitably display visible disruptions in their writing fluency. Instead, instruction might benefit from emphasizing process-oriented training that addresses early-stage writing activities, such as planning and organizing ideas, where anxiety may be more impactful. Encouraging students to engage in deliberate, mindful writing, rather than simply aiming for speed, may also help students manage anxiety more effectively. For example, implementing structured pre-writing exercises, modeling strategic plan-

ning techniques, and providing low-stakes writing opportunities could empower students to develop more resilient writing processes without sacrificing fluency.

To prioritize accuracy over fluency in second language writing instruction, teachers might implement activities such as sentence-combining exercises, grammar-focused editing tasks, or controlled writing tasks where students must use specific grammatical structures accurately. For example, instructors can assign short paragraph-writing activities that emphasize correct verb tense usage or provide model sentences for students to imitate. Accuracy-focused peer-review sessions, where students review each other's work specifically for grammar, vocabulary precision, or sentence structure, can also be beneficial.

In addition, to help manage writing anxiety, instructors could encourage students to strategically use external tools, such as bilingual dictionaries, online thesauruses, or grammar-checking software, during the drafting phase. Explicitly teaching students how to use these tools effectively; for instance, checking no more than two words per paragraph to maintain writing flow could help balance support with skill development.

In terms of measuring anxiety among our L2 writers, the SLWAI by Cheng et al. (2004) served as a reliable offline instrument. However, as we have highlighted, writing is a dynamic process<sup>[12]</sup>, and it could be methodologically insightful to employ online measures of anxiety, such as skin galvanic response. To date, the writing literature has seen limited research on using online measures to assess anxiety and writing performance. Additionally, in this study, we asked participants to write emails in response to simple and straightforward prompts. They were also allowed to use online dictionaries and other resources, which likely alleviated some of the anxiety they may have otherwise experienced. Certain writing genres, such as integrated reading-to-write tasks or argumentative essays, could elicit higher levels of anxiety due to their complexity, as they require synthesizing information from various sources. Future research might explore these more challenging tasks and writing genres to ensure that writers are appropriately challenged and their anxiety levels are adequately assessed.

As previous research suggests, affective factors like anxiety are not the only components influencing the writ-

ing process and performance. In addition to writing anxiety, several other factors, such as working memory, motivation, self-efficacy, and self-regulation strategies, can also play a significant role<sup>[61,62,65]</sup>. Due to time constraints and limited resources, we were unable to explore the dynamic interplay among these cognitive and affective factors in this study. As a result, we could not fully examine how writing anxiety might interact with cognitive processes and disrupt the writing process. Future research could offer valuable theoretical and methodological insights by investigating these factors in greater depth. Additionally, task complexity and genre may influence the fluency-accuracy relationship, as some writing tasks are more demanding than others (e.g., a narrative text versus an argumentative essay). Future research could investigate the impact of genre on this relationship, particularly exploring whether more cognitively demanding tasks, such as argumentative essays, affect fluency and accuracy differently.

Another limitation of the current study is the use of online tools, such as dictionaries, which were permitted during the writing tasks. While these tools may have helped reduce anxiety and facilitated the writing process for participants, they may also have influenced the accuracy and fluency of writing in ways not accounted for in this study. For example, students with access to online dictionaries might have been able to focus more on language accuracy rather than struggling with vocabulary recall, potentially masking the true impact of anxiety on writing performance. Future research should consider controlling for the use of such tools by either restricting access to external resources or incorporating it as a variable to better isolate the effects of writing anxiety.

The finding that writing anxiety did not significantly disrupt writing fluency may suggest that anxious learners are compensating through heightened cognitive effort or greater reliance on planning strategies. Although anxiety is often associated with cognitive interference, it is possible that in this context, learners managed their anxiety by slowing down during planning stages, carefully organizing their ideas before typing, or adopting structured approaches to mitigate the impact of emotional arousal. Another possibility is that anxiety may not equally influence all phases of the writing process; its effects might be more pronounced during the initial stages, such as topic

selection, outlining, or goal-setting, rather than during the transcription or revision phases captured in writing fluency measures. Future research could investigate these possibilities by using process-tracing methods (e.g., keystroke logging, think-aloud protocols) to examine stage-specific manifestations of writing anxiety.

Finally, one limitation of the present study is the lack of detailed information regarding participant background characteristics, such as language proficiency and typing skills. Although participants were drawn from a relatively homogeneous academic population, individual differences in these areas may still have influenced writing performance and process measures. Future research should systematically assess and control for such variables to enhance the generalizability of findings.

## 5. Conclusions

This study was grounded in the premise that writing anxiety affects writing accuracy and writing fluency. To explore this relationship, we analyzed the writing processes of 120 students using the keystroke logging software Inputlog, which allowed for detailed assessments of process characteristics. Our findings indicate that writing anxiety does not have a significant impact on text accuracy or writing fluency. However, writing fluency was found to influence writing accuracy: students who paused more frequently and produced fewer characters per minute on average tended to produce more accurate texts.

These findings differ from those of previous research, which can largely be attributed to methodological differences. In conclusion, while writing anxiety does not appear to significantly affect the fluency or performance of writers in the early stages of language development, writing fluency does have an observable impact on writing accuracy. Specifically, students who typed fewer characters per minute and paused more often were able to produce texts with fewer grammatical, lexical, punctuation, and spelling errors. Based on these results, we recommend that teachers and instructors prioritize accuracy over fluency when teaching beginner students learning to write in English or a second language.

## Author Contributions

Conceptualization, L.T.C. and H.T.T.N.; methodology, L.T.C.; software, L.T.C.; validation, L.T.C.; formal analysis, L.T.C.; investigation, L.T.C. and H.T.T.N.; resources, L.T.C. and H.T.T.N.; data curation, L.T.C.; writing—original draft preparation, L.T.C, K.X.N, and H.T.T.N.; writing—review and editing, L.T.C, K.X.N, and H.T.T.N.; visualization L.T.C. and H.T.T.N.; supervision, L.T.C. and H.T.T.N.; project administration, L.T.C. and H.T.T.N. All authors have read and agreed to the published version of the manuscript.

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## Institutional Review Board Statement

The study was conducted in accordance with the principles outlined in the Declaration of Helsinki. At the time of data collection, the university did not have a formal Institutional Review Board. Instead, the research protocol was reviewed and approved in writing by the Division of Personnel and Administration and the Faculty of Foreign Languages at Ho Chi Minh University of Industry and Trade (formerly Ho Chi Minh University of Food Industry). The Division of Personnel and Administration serves as the institution's official authority for ethical oversight, fulfilling functions equivalent to those of a formal Institutional Review Board or Ethics Committee. Ethical approval for this study was granted on April 6, 2023.

## Informed Consent Statement

Informed consent was obtained from all participants involved in the study. Participation was voluntary, and all participants were provided with written information about the study's purpose, procedures, and confidentiality measures prior to giving consent. The dataset used in this study was fully anonymized prior to analysis. All participants were de-identified by assigning unique codes, and no personally identifiable information was retained. This process ensured the confidentiality and privacy of participant data.

throughout the research.

## Data Availability Statement

The datasets, the coding syntaxes for R, and other materials related to this study are available upon request.

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## Conflicts of Interest

The authors declare no conflicts of interest.

## Appendix A: The Second Language Writing Anxiety Inventory

1. While writing in English, I'm not nervous at all
2. I feel my heart pounding when I write English compositions under time constraints
3. While writing English compositions, I feel worried and uneasy if I know they will be evaluated
4. I often choose to write down my thoughts in English
5. I usually do my best to avoid writing English compositions
6. My mind often goes blank when I start to work on an English composition
7. I don't worry that my English compositions are a lot worse than others'
8. I tremble or perspire when I write English compositions under time pressure
9. If my English composition is to be evaluated, I would worry about getting a very poor grade
10. I do my best to avoid situations in which I have to write in English
11. My thoughts become jumbled when I write English compositions under time constraints
12. Unless I have no choice, I would not use English to write composition
13. I often feel panic when I write English compositions under time constraints

14. I'm afraid that other students would deride my English composition if they read it

15. I freeze up when unexpectedly asked to write English compositions

16. I would do my best to excuse myself if asked to write English compositions

17. I don't worry at all about what other people would think of my English compositions

18. I usually seek every possible chance to write English compositions outside of class

19. I usually feel my whole body rigid and tense when I write English compositions

20. I'm afraid of my English compositions being chosen as a sample to be discussed in class

21. I'm not afraid at all that my English compositions would be rated as very poor

22. Whenever possible, I would use English to write compositions

## Appendix B: The Composition Task

### Read the email below:

To: Homeowner

From: Taryn Kent

Subject: Your home

Sent: January 7

Hello. I've been looking at the photo gallery of your online home buyer's ad. Congratulations on trying to sell your home without a real estate agent. It is difficult (we have done it twice) but is worth the effort if you find a reasonable buyer. My sister is interested in buying a home in your region. Your home could be ideal if you are willing to negotiate the price. Your asking price is about \$10,000 above her budget. She also wants to live near an elementary school and a bus route. I'm not sure if your home is near these amenities. Could you let me know about these details? Most importantly, are you open to negotiation on the price? Please let me know when the house would be available for viewing.

Thank you.

Sincerely,

Taryn Kent

**Directions:** Respond to the email as if you are trying to sell your house privately. Answer the questions and provide at least **TWO** details about the neighbourhood and

ONE reason why you can or can't negotiate the price.

You should write between 100 words to 150 words.

You have 40 minutes in total.

**Note:** You can use online dictionaries to look up words and phrases. DO NOT use Google Translate or any other translation tools.

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