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Impact of Auto-Correction Features in Text-Processing Software on the Academic Writing of ESL Learners

ABSTRACT

The intrusion of technology into language education is undeniable. However, its impact on English as a Second Language (ESL) learners remains unexplored. This study explores how the text-processing and suggestion features of Microsoft Word affect the English language development of ESL learners. The writing samples show that while beginners make fewer spelling and punctuation errors, prolonged reliance on software weakens long-term language proficiency. This finding is supported by cluster analysis of first-year undergraduates, third-year undergraduates, and postgraduates. Conversely, first-year undergraduates learners excel in structuring paragraphs and writing a variety of sentences, which are the areas untouched by automation offered in the tested software. Semi-structured interviews with research-active academics and postgraduate students further validated these findings, highlighting a critical decline in writing confidence due to over-dependence on emerging technology. The study underscores the hidden costs of convenience, urging a recalibration of technology-integrated language pedagogy.

Keywords: automated writing correction, ESL development, technology dependence, writing proficiency decline, text-processing software

Vpliv funkcije samodejnega popravljanja v programih za urejanje besedil na akademsko pisanje učencev in učenk angleščine kot drugega tujega jezika

IZVLEČEK

Vdor tehnologije v učenje jezikov je nesporen, a je njen vpliv na angleščino kot drugi tuji jezik premalo raziskan. Študija raziskuje, kako funkcije samodejnega popravljanja in predlogov v programu Microsoft Word vplivajo na razvoj znanja angleščine pri študentih in študentkah angleščine kot drugega tujega jezika. Pisni vzorci so pokazali, da začetniki naredijo manj napak pri črkovanju in ločilih, a dolgotrajna odvisnost od programske opreme oslabi dolgoročno jezikovno znanje. To potrjuje analiza prvega letnika, tretjega letnika in podiplomskih študentov in študentk. Prvi letnik se je sicer izkazal pri strukturiranju odstavkov in variiranju povedi, ki ju programska oprema ne avtomatizira. Polstrukturirani intervjuji z raziskovalci in raziskovalkami in podiplomskimi študenti in študentkami so ugotovitve potrdili ter izpostavili občuten upad samozavesti pri pisanju zaradi pretirane odvisnosti od sodobne tehnologije. Raziskava izpostavi skriti davek udobja in nujnost ponovnega uravnoteženja pedagoških pristopov pri vključevanju tehnologije v jezikovni pouk.

Ključne besede: samodejno popravljanje pri pisanju, razvoj ESL, tehnološka odvisnost, upad pisne zmožnosti, programska oprema za obdelavo besedil

1 Introduction

The advancement of social and technological development has introduced auto-correction features integrated into text processors, continuously reshaping the terrain of the language competence of English as a second language (ESL) users. Auto-correction refers to digital spelling and grammar correction tools embedded in word-processing programs, which automatically detect errors and either suggest corrections or directly rectify them (Wood 2014). These features were first implemented in the 1980s as a strategy to boost the demand for computers (Cummings 2023; Kruse and Rapp 2023; Larsson and Teigland 2020; Steyn and Johanson 2011). According to the predictions of that era, spell-checker programs were predicted to become a mandatory feature in future text-processing programs. The service provides users with correct spelling or grammar before they can even recognize their mistakes; later, however, it emerged that these programs negatively influenced the writing and language performance of its users (Baron 2023; Omer Ismael et al. 2022; Rüdian, Dittmeyer, and Pinkwart 2022).

Scholars have identified that the auto-correction feature in word-processing programs operates through three primary mechanisms:

- (a) direct corrections that provide the corrected form of error on the spot,
- (b) indirect corrections that direct users' attention to the errors but leave users to select the correct option, and
- (c) metalinguistic corrections where the program identifies the errors, labels the errors based on their nature and provides a brief explanation, with or without relevant examples (Barrot 2023).

However, technology and language experts hold conflicting views regarding the impact of these features on the language competences of English learners beyond the inner circle of Kachru's (1985) 'Three Concentric Circles' model. Accordingly, the inner circle represents countries where English is the primary language (e.g., the UK, the USA), the outer circle includes ESL contexts where English serves as an institutionalized additional language (e.g., India, Nigeria), and the expanding circle comprises EFL (English as a Foreign Language) contexts where English is learned as an international language but lacks official status (e.g., China, Saudi Arabia). The negative effects of auto-correction may be more pronounced in outer and expanding circle countries, where learners often rely on normative standards from inner-circle varieties, potentially influencing their linguistic development in ESL (norm-developing) and EFL (norm-dependent) contexts (A. Al-Mutairi 2019; Hu and Jiang 2011). One critical statement claims that this technology has 'created a generation of dummies' (Wood 2014, 12). On the contrary, Weigle argues (2013) that providing corrective feedback is essential as it addresses deficiencies in students' linguistic repertoire, particularly in advanced writing, which can be corrected easily. Furthermore, it highlights quicker and potentially more effective methods for improving academic writing through integrated auto-correction features in text-processing tools.

Studies have validated the advantage of the auto-correction features in text-processing applications, as it enables users to compose relatively error-free text (Neto, Bezerra, and Toselli 2020; Putze et al. 2017). Moreover, it determines which words are most likely to have been

intended and then fixes the text accordingly, which enhances accuracy in technical aspects of writing, improving readability and consistency throughout the document, additionally reducing the cognitive load of writing, allowing greater focus on content and ideas (Sanchez et al. 2023).

Continuous reliance on these features has intensified challenges for ESL and EFL learners, particularly in spelling, note-taking, and instant essay writing (Omer Ismael et al. 2022; Sanchez et al. 2023). It affects student writing abilities because users often fail to notice their mistakes on account of automatic correction (Kontogiannis 1999). The issue causes users to not fully internalize spelling and grammar rules (Ajaj 2022), leading to weaker writing skills over time. This is detrimental for students from an ESL context since they lack English language input from the broader society/environment (Saud et al. 2023) like the inner circle countries (Hu and Jiang 2011). It is thus vital to explore the impact caused on ESL learners' language competency by the auto-correction feature in text-processing applications. The present study focuses on the effects of auto-correction technology on the English writing skills of ESL undergraduates. Insights from the on-site test experience and interviews with research-active academics and postgraduate participants will ensure the quality and validity of the findings.

The findings of this study will assist in identifying the long-term impact of text processors with auto-correction and serve as an initial step towards potential technological developments that could overcome these drawbacks. The following section investigates the existing literature relevant to our study.

2 Literature Review: Empirical Studies on Auto-Correction

While text-processing applications with automatic corrective feedback enhance language learning, their use in ESL contexts has shown harmful effects. Kim (2012) stated that error correction is ineffective and harmful in physically interactive learning environments. Similarly, studies have indicated that it is ineffective to expect language development through automatic correction since the student/ learner is unaware of the error he/she has committed (Truscott 1999). Despite concerns about grammar or spelling, students often fail to recognize their errors and misunderstandings. On the contrary, Rüdian et al. (2022) claim that auto-correction is a promising tool for ESL language users, as it helps to minimize the gap between teacher expectations and learner skills, and over 66% of the errors identified by educators were not detected by the auto-correction software (designed for German language). The study also found that the software frequently flagged correct items as errors, causing confusion and undermining its reliability. These findings highlight the need for auto-correction tools to move beyond basic proofreading toward a more comprehensive approach to language learning (Alharbi 2023).

Another study found that automated feedback systems improve writing quality and outcomes, but it unveiled shortcomings in ESL/EFL contexts (Benali 2021). Further, Ferris and Roberts (2001) explored effective methods for providing error correction feedback, but their study highlighted the scarcity of existing literature on the impact of auto-correction on English language learners in ESL contexts.

Another significant study examined the impact of automatic spelling correction, focusing on learners' awareness of how the software functions, corrects spelling mistakes, its educational value for learning English spelling, and learners' dependence on the tool for checking their spelling (Lin, Liu, and Paas 2017). The study found that male learners were generally more competent and benefited more from the software, with the sample showing an overall positive preference for the auto-correction feature (Rahimi, Gholizadeh, and Shahryari 2019). Conversely, the study of Ali et al., (2022) found that learners who relied heavily on technology for spelling correction faced greater challenges in maintaining spelling accuracy during writing tasks. Supporting this argument, Wood (2014) highlighted, a survey revealed that students who heavily depended on smart devices performed worse in spelling than those who had less interaction with such devices and spell-check features. She further explained that millennials, as an emerging generation, often lack three essential skills: reading, writing, and metalinguistic awareness (Vodopijja-Krstanović and Brala Vukanović 2015; Wood 2014).

The study by Gayed et al. (2022) explored the impact of writing tools on L2 writing proficiency, highlighting broader implications of auto-correction technology for ESL learners' language development. While the findings indicated a positive impact on syntactic complexity, results for other measures and production rates were inconclusive. The authors attributed these inconsistencies to several factors, including the participants' limited experience with the software, low usage rates of the word suggestion feature, and the inherent limitations of machine-based assessment tools. They argued that automated systems might fail to capture nuanced writing features, such as contextual and structural errors, which human evaluators can better identify. These findings highlight important considerations for implementing auto-correction tools in ESL contexts. While such tools may support immediate syntactic improvements, their influence on deeper language development remains uncertain. Outcomes are shaped by factors such as technological familiarity, typing proficiency, and the ability to interpret corrections. The study emphasizes the need for comprehensive training and ongoing tool refinement. Furthermore, predictive text and word suggestions may distract less proficient learners, requiring closer evaluation. Thus, auto-correction technology, though promising, must be carefully aligned with learners' needs and proficiency levels.

Sanchez (2023) studied how auto-correction tools impact students' writing abilities across various dimensions, including vocabulary, syntax, and writing mechanics. The findings revealed marginal performance in student composition, suggesting limited mastery in key areas of writing. For instance, vocabulary assessment consistently yielded a marginal rating, indicating a dependency on auto-correction tools for word choice. Similar trends were observed in syntax and mechanics, where a sizeable portion of students scored poorly, indicating persistent grammatical and structural errors in their writing despite using these tools. This suggests that while auto-correction provides immediate corrective feedback and improves surface-level errors, it may inhibit learners from developing deeper linguistic skills. Furthermore, those participants often relied on auto-correction tools not just for error correction but also as idea generators and time-savers, reflecting a shift in focus towards ease and efficiency over language mastery. These findings underscore that auto-correction tools boost confidence and efficiency but may hinder authentic language learning and critical thinking when overused.

Research indicates that integrating automated feedback with traditional teacher feedback improves ESL learners' writing skills. A recent study on Turkish EFL students found that this combined approach significantly enhanced writing self-efficacy compared to traditional methods (Sari and Han 2024). This aligns with prior studies by Grimes and Warschauer (2010) and Sherafati et al. (2020), which revealed that automated writing evaluation (AWE) tools, by providing immediate, personalized feedback, promote self-efficacy and learner engagement. These systems enable students to practice without time or space constraints, thereby enhancing confidence and allowing for iterative revisions. However, mixed results were observed in other areas, such as self-regulated writing strategies and writing anxiety. While the combined feedback model did improve self-regulation, it did not significantly reduce anxiety levels, possibly because of the continued role of teacher evaluation. Despite these variations, the immediate and individualized feedback offered by AWE systems has been shown to improve writing performance and facilitate more efficient error correction, suggesting that this hybrid feedback model could contribute positively to language development in ESL contexts. This supports the broader argument that automated feedback can foster a more student-centred and effective learning environment, enhancing both writing proficiency and psychological factors critical to language acquisition.

Despite the existing empirical evidence, the limitations in scope and narrow focus of previous studies underscore the requirement to explore emerging trends that are associated with technological advancements and their impact on educational practices. A significant concern that necessitates this study is the overemphasis on Middle Eastern and Western contexts in the literature (Ali et al. 2022; 2022; Benali 2021; Omer Ismael et al. 2022; Wood 2014), leaving a gap in research that addresses the Asian context, where findings could be applicable across the broader ESL landscape. Moreover, the post-COVID-19 learning environment in developing countries has introduced significant changes in educational practices, policies, and technology, leading to increased reliance on technology in the teaching-learning process (Bećirović, Brdarević-Čeljo, and DeliĆ 2021). This over-reliance on technology has created a detectable phenomenon in millennials (Shadiev and Wang 2022), which needs immediate exploration. Therefore, this study is timely, as it aims to address this research gap and identify potential negative consequences of neglecting these issues, contributing to both academic discourse and socially significant outcomes for future generations.

3 Methodology

3.1 Setting

This study examines the impact of auto-correction features of text-processing applications on ESL undergraduates' English language competences. A pre-designed test was deployed as the research instrument to gather evidence (Ahmed 2024). Furthermore, a series of semi-structured interviews with both undergraduate and postgraduate clusters was conducted to ensure the validity and reliability of the data and to obtain more precise findings (Leung 2015). The study was conducted as a cross-sectional investigation (Maier et al. 2023), in which data were collected at a specific point in time.

3.2 Participants

This experimental study involved 197 undergraduates from a state-governed university in Sri Lanka who regularly engage in academic writing (assignment submissions, end-of-semester examinations, field report composition, spot tests, etc.). The postgraduate cluster, used for the semi-structured interview series, included twenty postgraduate students.

The undergraduate cluster of the sample comprised Year I Semester I (here onwards, the term YI SI will be used) and Year III Semester II (here onwards, the term YIII SII will be used) undergraduates from the discipline of spatial sciences. The participants were selected to preserve the validity and reliability (Leung 2015) of the data.

According to Table 1 below, these undergraduates aged between 19 and 26, are pursuing their Bachelor of Science in Spatial Sciences, representing both genders. Most of the sample had limited and inconsistent exposure to computers and the internet prior to entering university (Lekamge and Rajavarathan 2024). The subject General English is offered as part of the Advanced Level examination. However, the results of General English were not considered for university admission in this degree program, leading to significant variation in language competency among undergraduate students.

TABLE 1. Composition and demography of undergraduates who were tested for the experiment and postgraduates who were tested for semi-structured interviews.

Year of Study	Cluster 1 - Undergraduates		Cluster 2 – Postgraduates
	Year I Semester I	Year III Semester II	Postgraduates
Age	19–22	22–26	28–40
Gender	Male – 71 Female – 28	Male – 66 Female – 32	Male – 13 Female – 07
Mother Tongue	Sinhala – 78 Tamil – 21	Sinhala – 82 Tamil – 16	Sinhala – 16 Tamil – 04

The Sri Lankan secondary education system predominantly relies on face-to-face learning and a mother tongue (MT/L1) based teaching-learning process (Lekamge, Jayathilake, and Smith 2024), contributing to a low level of computer literacy and English language proficiency for some students in the initial phase of their university education. The students come from two different first-language (L1) backgrounds, as the majority speak Sinhala (L1), and the others Tamil (L1) (Prasangani 2018). To ensure consistency in instruction, the researcher served as the teacher for both the undergraduate and postgraduate clusters. Informed consent was obtained from all students before they participated, in accordance with research ethics (Wu et al. 2019).

3.3 Development of the Research Instruments and Data Collection

Once the preliminary list of errors was identified from existing literature (Hlárdek, Staš, and Pleva 2020; Nejja and Yousfi 2015), the types of errors were identified and listed. Then, to ensure triangulation for validity and reliability, a pilot study was conducted through an online platform with a randomly selected group of ten undergraduates and five postgraduates. The pilot study was vital to ensure the responsiveness and applicability of the tested items (Reed

et al. 2021; Vivek, Nanthagopan, and Piriyaatharshan 2023). Then, the finalized error list was composed, and each minute error type was classified under a sub-category for ease of handling the results. The required terminology and possible error types were included in the tested items. Further, the postgraduate cluster was questioned with reference to the impact caused by long-term use of this software.

A. On-site test designed to gauge the real-time impact of auto-correction on writing

The first research instrument was the pre-designed test targeting the undergraduates, which consisted of three tasks divided into two subcategories.

Task one was designed to assess the hand-written competency of students in academic activities. The tasks aimed to assess student competence in listening to academic content and composing relevant notes, addressing potential errors identified in the pilot study. This included terminology that was subject to auto-correction and technical terms specific to the academic discipline of spatial sciences. The students had to compose a 200-word paragraph within the allocated time for each task.

Task two was a computer-based test, which was completed in a notepad application with no auto-correction options. Students were given two parts under the second task and asked to submit the saved notepad answer to the link provided at the end of task two.

Task three was designed to be completed in a Microsoft Word document (hereafter, a Word document), with auto-correction features. The task had two parts, requiring students to type their answers in the Word document. Each task carried the same weight as previous tasks and was related to the main academic discipline of spatial science. All three parts of this test were designed to include the required terms that helped assess the spelling and grammar concerns that were tested in the experiment (Catelly 2014; Hair et al. 2024; Ren and Seedhouse 2024). The test design is displayed in Figure 1 below.

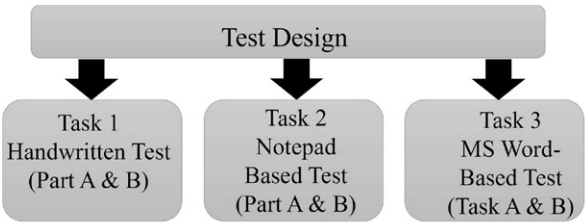


FIGURE 1. Design of the test.

B. Semi-structured interviews targeting the postgraduate cluster

A series of semi-structured interview was conducted with twenty postgraduates who were willing to participate in an online session of 10-15 minutes. Qualitative interviews carry higher validity in triangulating the data and obtaining authentic viewpoints and experiences relevant to the study (DeJonckheere and Vaughn 2019; Magaldi and Berler 2020). Thus, the topic areas for the interview were designed with extensive reference to and adaptation

of prevailing literature. Accordingly, the interview questions covered attitudes toward auto-correction and its impact on academic writing, language learning, and development. It also addressed the accuracy and common errors of auto-correction, its effect on writing style and tone, the availability and compatibility of platforms, challenges and limitations faced by ESL learners, its impact on confidence in English language usage and writing, and long-term changes in writing practices (DeJonckheere and Vaughn 2019; Ranalli and Yamashita 2022; Sanosi 2022; Wei, Wang, and Dong 2023).

3.4 The Procedure of the Study

The first research instrument (on-site test) occupied seven major steps. Initially, a suitable testing approach was designed for the experiment with three tasks to test each aspect of the research. To obtain the expected outcomes, the test was divided into three sections. Each section had its own significance to the main objective of the study:

- a) The first part involved handwritten tasks to assess students' on-site writing competence without technology support. This aimed to reveal their independent language proficiency and confidence, isolating language skills from computer literacy and typing speed.
- b) The second part involved notepad-typed content to assess students' language errors without auto-correction support, though results could be influenced by typing speed and computer literacy.
- c) The third part involved a composition typed in Microsoft Word, which offers auto-correction, to identify language issues beyond the software's corrective capabilities.

These three test sections allowed the researcher to identify gaps at each phase, with comparisons revealing how students increasingly rely on technology-enhanced tools without developing independent language competences. For the on-site test, participants were selected from YI SI and YIII SII undergraduates. The interview series targeted postgraduate students with extensive experience using text-processing software for academic, professional, and research purposes, aiming to explore the long-term effects of continuous software exposure and to enhance the validity of on-site test results (Kakarash 2023; Morse et al. 2002; Van der Loo and de Jonge 2020).

The majority of YI SI students are not well exposed to computer literacy and related technology (De Silva, Kodikara, and Somarathne 2014; Gamage and Halpin 2007; Lekamge and Rajavarathan 2024). The YI SI group was selected for their limited exposure to auto-correction and text-processing software, while postgraduate students, with the longest exposure, provided stronger validation for the findings. The analysis focused on how continuous software exposure affects writing performances of ESL learners. YIII SII students, with considerable exposure to online learning and text-processing tools, offer an intermediate perspective. Thus, the three clusters ensure data accuracy across varying stages of technological exposure (Van der Loo and de Jonge 2020).

The third phase involved task preparation, obtaining approvals, and informing students of test procedures. Postgraduate interviewees were notified two weeks in advance, briefed on

question areas, and invited to participate voluntarily. The fourth and most challenging phase was on-site test administration, conducted by three instructors. Instructions were clearly communicated at the beginning and end of each task, with specific time allocations. Upon completing each task, students submitted responses via a Google Form. Collected scripts were then reviewed, and purposeful sampling was used to select complete submissions from ninety-eight participants (Naderifar, Goli, and Ghaljaie 2017).

Researchers used content analysis to examine error patterns in each task of the undergraduate on-site test (Amnuai 2020; Salehi and Bahrami 2018). The interview scripts were first translated into English and then analysed using qualitative thematic analysis (Braun and Clarke 2006; Kiger and Varpio 2020; Naeem et al. 2023; Rosairo 2023; J. Singh and Eisenschenk 2021) to generate codes, which were later transformed into themes of the study. Finally, the data from the on-site test and interviews were manually examined to detect existing phenomena with supporting evidence. The data were qualitatively analysed through error analysis and qualitative thematic analysis. Error types were identified in each test phase, and the findings were compared using descriptive thematic analysis (Baxter 1991; Braun and Clarke 2006; Kiger and Varpio 2020).

4 Discussion and Analysis

The discussion and analysis section is organized with two primary concerns:

- (i) to establish the influence of the automatic spelling correction feature on writing skills of ESL context English language learners and
- (ii) to assess the impact of identifying misspelt words and providing suggestions and the role of grammatical suggestions, as displayed in Table 2.

The primary features offered by the software (MS Word) are as follows: automatic spelling correction feature and grammar correction, as well as suggestions for misspellings, vocabulary, stylistic issues, and other writing errors.

Based on the overall performance of the participants, the study identified various persistent error types at each phase of the analysis. These error types were categorized into subcategories and main categories to facilitate data processing and analysis (Figure 2). These categories are as follows:

- (a) grammar errors – subject-verb agreement, tense consistency, pronoun reference, and sentence structure;
- (b) spelling errors – grapheme, transposition, substitutions, insertions, omissions, case sensitivity, double letters, and homophones;
- (c) punctuation errors – misplaced or missing commas, apostrophe errors, and missing periods;
- (d) vocabulary errors – incorrect word usage, redundancy, clichés, and jargon;
- (e) stylistic errors – lack of clarity, tone and register issues, and insufficient sentence variety;
- (f) other errors – repetition, paragraph structure issues, improper citations, and incompleteness.

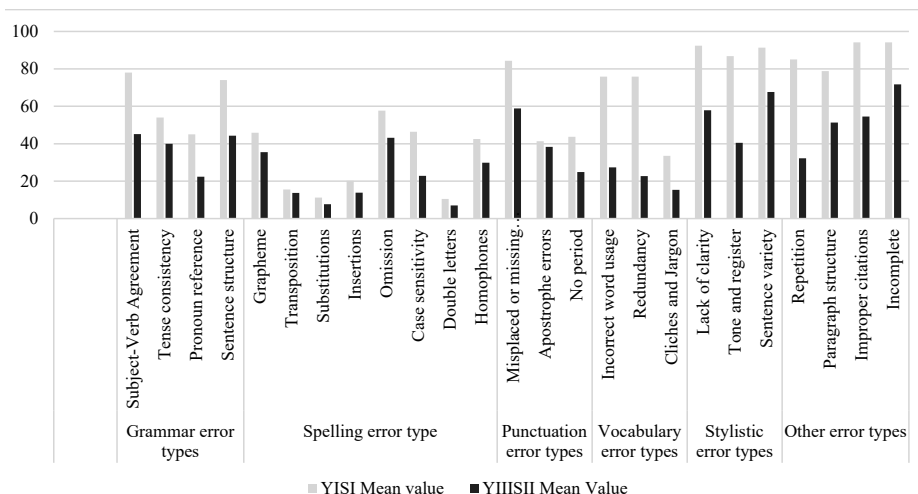


FIGURE 2. Identified error categories among the sample (YI SI and YIII SII undergraduates).

Since the focus of this study is the impact of auto-correction features in text-processing applications on the language development of learners in the ESL context, unrelated concerns and error types were excluded from analysis.

4.1 Impact of Automatic Correction on Language Performance

The comparison of three tasks (hand-written, notepad-based, and Word document-based) revealed certain limitations in the automatic spelling correction. Specifically, the software does not correct all spelling errors made by users, as it relies on a pre-installed auto-correction word list, which reveals the limited effectiveness of the software (Fitria 2021). While software often corrects mistakes automatically without user awareness, this feature poses drawbacks for long-term users (Hiscox, Leonavičiūtė, and Humby 2014). Over time, their attention to key language aspects, such as spelling and punctuation, may diminish (Fan and Ma 2022). These findings will be further validated by the postgraduate sample. All postgraduate interview participants concurred that prolonged and continuous exposure to text-processing software significantly contributed to spelling and punctuation errors when operating in non-technological environments, as it made them heavily dependent on the technology. These elements are crucial in academic writing, underscoring the profound impact of long-term software use (Brenner et al. 2021; MerziFonluoğlu and Takkaç Tuglar 2023). Table 2 illustrates compelling evidence from graduates who experienced serious effects from auto-correction features over time. Notably, these participants occupy a unique transitional period, having witnessed the introduction of technology into education.

Graduates who pursued their undergraduate studies in the late 20th century and early 21st centuries had substantial engagement with hard copies of books/documents and manual notetaking using pen and paper. This method indirectly fostered their cognitive and language development processes (Baker 1994; Dickinson et al. 2012). In contrast, the evidence presented by the sample highlights a clear distinction between the pre- and post-effects of

reliance on text-processing tools. The Sri Lankan primary and secondary education system, which traditionally emphasized physical, hand-written work, contributed positively to students' spelling and language accuracy, which incorporated metacognitive concerns (Baker 1994). However, as students progressed into tertiary education and gained more exposure to digital technology, the anticipated language improvements stagnated or declined.

A comparative analysis of hand-written content between YI SII students and YIII SII students provided additional insights. The YI SII cohort, with less exposure to text-processing software, had fewer errors in spelling and punctuation. The reason is the impact of the traditional learning mode during their school years, with more focus on pen-and-paper based writing (Vičič 2020), extracting and learning. In contrast, the YIII SII students, who relied extensively on technology over an extended period (three or more years in the university during the COVID-19 pandemic), showed no marked improvement in their hand-written assessments. This pattern suggests that extensive dependence on auto-correction tools diminishes the language awareness of students, leading to persistent errors that hinder academic writing precision (Baker 1994).

TABLE 2. Themes developed from the semi-structured interviews with postgraduate students.

Theme	Interview responses
Limitations and challenges in using auto-corrections in text-processing applications	A. sometimes, we do work or research on a specific field, ... But when we insert some technical terms, the Word app does not accept those and automatically provides some other words with a different meaning ... B. Because scientific terms, technical terms and other subject-specific acronyms are not provided in Word, so we need to add those terms into the dictionary manually and again, these terms get inter-mingled with other terms later, and sometimes it automatically corrects the terms with other words according to its pre-installed rules. C. Word document has no connection with the writing style and the tone of the composition. The Word software does not address these stylistic concerns ...
Coping mechanisms for overcoming limitations	D. Hmm ... yes, I think I have lost my confidence in spelling when compared to school days and undergraduate days. During my undergraduate years, I am talking nearly 15 years back, okay? We did everything manually, drafted maps manually, wrote our field reports manually, submitted our assignments manually, composed tutorials, and reports manually, referred to hard copies of books and documents, noted things manually and referred to hard copies of books in the library. From all those activities, I was so confident about my language, which improved drastically once I started my undergraduate degree, and reading the prescribed books in the library and noting and extracting things manually seriously impacted my language development ... But once I started doing my master's and other research and academic works with technology, let's say after 2010 onwards, I strongly used computers and used softcopies of documents and started copying and pasting, which is easier and more efficient but has drastically impacted my language competency, ... I feel like I am stuck and not any development ... impact of software must have contributed a dominant proportion to this dependency. E. ... Thus, I use the Word software always, but now I use AI tools more often to finetune my language and writing style. I would draft the initial content in a Word document and then use the available AI tools to enhance the quality of the writing style and omit the grammatical errors.

Impact of text-processing software on language development among ESL context users	F. rather than for language development, it makes it easier and more efficient to handle the situation. Actually, we do not usually focus on language development; ... But ... we identify that some sort of grammatical suggestions provided in the word app make us aware of our mistakes. For some users, this can be helpful in identifying that they have grammar mistakes. I don't think it is a successful way to develop language skills. G. it has an impact on language development, but it is very limited, right? It provides some suggestions and corrections in some instances, but that is not sufficient and a good way to proceed. But, if someone is intentionally trying to learn through every minute instance as an opportunity to develop their language, then this can be considered as a sufficient way to develop language skills. But I don't know whether Word can cover all grammar concerns, especially when it comes to complex, longer sentences. However, for learners at the beginner level, to compose a composition with fewer errors, Word is beneficial. H. I believe that Word automatically corrects major grammar errors like subject-verb agreement, and spelling errors, capitalization stuff and period related concerns, but this automatic correction might harm learners because the user has no idea whether he has written correctly because prior to detection, the software itself corrects the error. However, I admit that the suggestions provided by Word for grammar and spelling concerns have a severe impact on learning language. Because the suggestion or explanation can lead the user towards a better understanding of the language. On the other hand, automatic correction can lead users towards lack of awareness about writing mechanics that are mandatory for academic concerns. I. However, auto-correction ..., is not a good thing. Because, I personally must admit that the worst scenario is my experience: I once participated in a spelling competition during my school days, and I was very good at English compared to my colleagues back then. However, now, the changes that have happened to me are actually very bad. Now I am not confident of my spelling capacity, and I always recheck it with an available online tool. Even though working as an academic and a researcher, I am continuously engaging with text processors. But I recognized that whenever I have to write something using pen and paper, I get stuck with spelling, seriously.
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Figure 4 illustrates the most relevant error types that the automatic correction feature directly addresses, often without user awareness. These error types include spelling and punctuation. The most significant sub-categories are omission errors, case sensitivity issues, double letters in spelling, misplaced or missing commas, apostrophes, and the absence of periods. The postgraduate cluster provides evidence that continued exposure to text processors seriously affects the writing mechanics of users, as is evident in the answers of Interviewees H and I in Table 2. Accordingly, the long-term exposure of this middle-aged cluster, who experienced the transition from the conventional mode of learning to the flipped mode after the pandemic, indicated a deterioration in their spelling confidence due to prolonged entanglement with technology-enhanced writing tools (Reed et al. 2021; Wei, Wang, and Dong 2023).

When comparing the three tests, most errors were found in tasks completed using the notepad, possibly owing to typing speed, technical literacy, and related challenges (Van Waes et al. 2021). Comparison of handwritten content with text-processed content showed a significant reduction in most error types, particularly no-period errors, case sensitivity issues, and omissions (Figure 3). This suggests that text-processing software has a positive short-term impact on producing more accurate written work (Van Der Steen, Samuelson, and Thomson 2017). However, its

long-term use negatively affects human autonomy, language competence and user confidence (Bickmore and Picard 2005; Schaefer et al. 2016).

Year-based analysis highlights the significant impact of punctuation errors. As shown in Figure 3, punctuation errors were notably reduced in text-processed content compared to handwritten and notepad tasks. However, many third-year undergraduates continued to exhibit punctuation errors in handwritten work, likely because of prolonged reliance on automatic correction, which conceals such mistakes (Van Waes et al. 2021). Consequently, the quality of their hand-written work shows minimal improvement over that of newly enrolled undergraduates. A key factor underlying this trend is the foundational cognitive development that occurs during school years. Activities that integrate traditional methods of writing played a critical role in establishing robust language mechanics (Kellogg 2008). However, the transition to university-level education, particularly during the COVID-19 pandemic, drastically altered the learning environment. Conventional, in-person educational practices in Sri Lanka were abruptly replaced by rigid online modes, causing a significant disruption without sustainable curricular adjustments and required facilities (Lekamge and Rajavarathan 2024). This shift fostered heavy dependence on digital tools, leaving students without essential skills in traditional writing practices and increasingly reliant on technology for language functions.

The results suggest that prolonged reliance on auto-correction may delay language learners' ability to produce error-free compositions, diminishing their innate writing accuracy over time, as reflected in the persistence of minor errors (Omer Ismael et al. 2022). This finding is further supported by the postgraduate cluster, who reported losing confidence in producing error-free content. The long-term impact of heavy technological dependence, particularly the auto-correction feature in text-processing applications, negatively affects user confidence (Bickmore and Picard 2005; Schaefer et al. 2016).

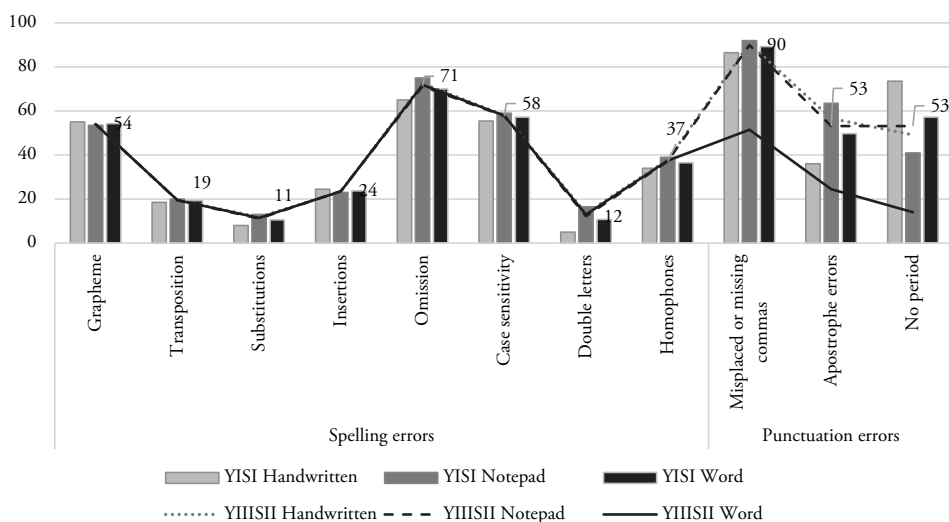


FIGURE 3. Detected errors (by year): How exposure to technology has affected the language performance of undergraduates.

4.2 Impact of Identifying and Emphasizing Errors to the User

The second feature of text-processing applications highlights incorrect words, grammatical issues, and other language concerns, offering suggestions for correction (Kukich 1992; S. Singh and Singh 2018). According to results, this feature covers a broad range of errors: grammar rule-related errors, spelling errors, vocabulary-related errors, and other error types. This feature positively impacts language learners in the ESL context by identifying areas that need improvement and raising awareness of their mistakes (Wood 2014). This capability is useful in highlighting errors in answer scripts, allowing learners to develop their language skills through cognitive engagement (Pinet and Nozari 2022; Rüdian, Dittmeyer, and Pinkwart 2022; Sherafati, Largani, and Amini 2020). When users click on a highlighted error, the software offers accurate suggestions, aiding conscious correction. Users can also add technical terms to the dictionary or auto-correction list, benefiting academic writers by allowing them to focus more on content rather than on language errors (Khansir 2012). However, the postgraduate cluster revealed that the software often fails to recognize technical terms and acronyms, automatically replacing these with similar-looking alternatives (Table 2 – Interviewees A and B). To avoid this, users must manually add scientific terms to the software dictionary (Cook and Jensen 2019; Salton and Lesk 1968). However, manual additions are not feasible for all users on account of their varying levels of comfort with technology, and the fact that continuous dictionary updates are time-consuming.

However, the feature serves as a positive catalyst for language learners in ESL contexts, as it integrates cognitive processes with the task (Goonawardena et al. 2022; Rüdian, Dittmeyer, and Pinkwart 2022; Wood 2014). By purposefully correcting highlighted concerns, users experience a significant impact on their cognitive processes, leading to a conscious awareness of errors (Ellis et al. 2008; Pinet and Nozari 2022). Additionally, the provision of grammar suggestions enhances learners' theoretical understanding of grammar rules (Ellis et al. 2008; Ji and Liu 2018). Consequently, this approach enhances language accuracy by reducing the potential harm caused by the software to language users by its suggestion provider feature.

For further clarification, twenty answer scripts were randomly chosen for review based on mistakes highlighted by the Word software, as displayed in Figure 5. Regardless of study phase, most errors were in spelling (above 300 occurrences) and punctuation (above 250 occurrences). Thus, a significant finding is that the software fails to identify stylistic aspects and some vocabulary errors (Putze et al. 2017; Rüdian, Dittmeyer, and Pinkwart 2022; Shadiev and Wang 2022). MS Word does not address writing style, paragraph structure, coherence, or cohesion. Long-term users of the software report that they incorporate larger-scale AI tools to enhance their writing style, coherence, and cohesion (Tica and Krsmanović 2024). This clearly prompts software developers to enhance the features in text-processing software (Alharbi 2023; Benali 2021; Gayed et al. 2022; Jajić Novogradec 2021; Ranalli and Yamashita 2022; Salton and Lesk 1968).

Compared to the Word document-based task, YIII SII students showed a reduction in error occurrences, with the greatest decrease in other error types such as repetition and incomplete terms. Punctuation errors (apostrophe and comma issues) followed in reduction,

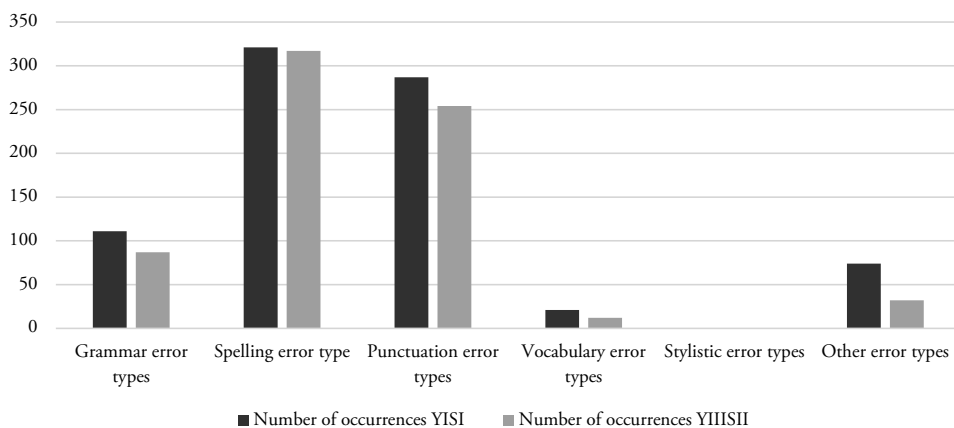


FIGURE 4. Number of occurrences of error types as highlighted on the task sheet (completed using text-processing software).

while grammar errors, including tense and subject-verb agreement, showed the third most significant improvement (Fan and Ma 2022; Ferris and Roberts 2001). However, spelling errors show the lowest difference across each year of study. That hinders the proficiency of students in technical and subject-related terminology. These terminology-related spelling error concerns are common in their hand-written content and are displayed in Figure 5.

As shown in Figure 5, most errors were found in the YI SI cluster. However, YIII SII students committed notably more punctuation errors in the handwritten task, with a count of 221, while other error types were lower compared to the YI SI cluster.

Apart from that, stylistic errors were not detected by the text-processing software (Gröndahl and Asokan 2020; Stamatatos, Fakotakis, and Kokkinakis 2000), resulting in no recorded values for these errors in Figure 4. However, the researcher identified numerous stylistic errors in the hand-written content (Figure 5), particularly in the subcategories of clarity, tone, register, and sentence variety.

Incorrect word usage was a recurring error in the sample. However, the software failed to detect it, because the pre-installed logic lacks the capacity to interpret semantic accuracy or assess the higher-level cognitive attributes involved in human language processing (Rüdian, Dittmeyer, and Pinkwart 2022; Salton and Lesk 1968; Wood 2014). Hence, this limitation highlights a significant gap in current text-processing applications. However, the most recent developments in artificial intelligence (AI) have begun to address this concern, as evidenced by the data obtained from the postgraduate cluster (Table 2). Another noteworthy observation is that the software did not identify issues related to paragraph structure and organization. These issues were highly apparent in the YI SI cluster but were significantly less prominent in the YIII SII cluster. This insight further supports the fact that, with gradual exposure to the language through CLIL (Content and Language Integrated Learning), students make noticeable progress in their language development. This valuable insight emerged as a by-product of the study and is worthy of further exploration.

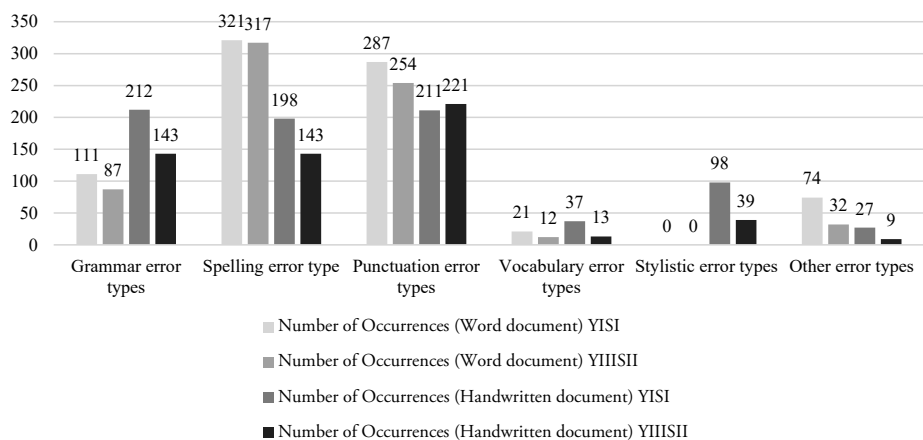


FIGURE 5. Year-wise comparison of error occurrences: A comparison between the hand-written content and the text-processing application-based content.

Another significant finding is that students in the YI SI cluster demonstrate stronger language skills in their hand-written work (spelling basic terminology and punctuation use). As these students gradually gain exposure to subject-specific terminology and technical terminology, the frequency of errors decreases, as observed in the YIII SII cluster. In contrast, students in the YIII SII cluster exhibit a higher frequency of punctuation errors, likely due to continued reliance on text-processing software. The most noticeable effects of this reliance on text-processing software become apparent during hand-written assessments, where automated support is unavailable. These findings are also reinforced by triangulated data from the postgraduate cluster, emphasizing the pervasive impact on writing mechanisms. The data illustrate that this issue is not isolated but a widespread concern that affects many users. Prolonged dependence on auto-correction features has resulted in a gradual decline in essential language competences, signalling an urgent need for intervention to preserve and enhance human cognitive abilities in language functions (Brenner et al. 2021; Huseinović 2022; MerziFonluoğlu and Takkaç Tülğar 2023).

Another notable finding identified in the study is the recurrent use of abbreviated forms and informal texting language in the hand-written content (Booton, Hodgkiss, and Murphy 2023; Dwivedi et al. 2023; Genlott and Grönlund 2013; Jonsson and Bläsjö 2020) in both clusters. This phenomenon adversely affects their academic writing, often introducing an inappropriately informal tone into formal writing samples.

The evidence indicates that text-processing applications exert both positive and negative influences on the academic language development of ESL learners (Alharbi 2021; Mahapatra 2024). Thus, the current study highlights the importance of language instructors and educational practitioners strategically leveraging the beneficial aspects of these tools to enhance the linguistic competence of learners. Simultaneously, it suggests that software developers should incorporate features that actively engage cognitive processes, promoting more effective language development rather than focusing on the efficiency of text production (Booton, Hodgkiss, and Murphy 2023; Jia et al. 2019; Khan et al. 2023).

5 Conclusion

The study reveals that text-processing software (MS Word) with features such as auto-correction and error suggestions can provide valuable support in reducing certain language errors and increasing user focus on quality content. However, it also poses long-term challenges to language learners in the ESL context by making the users more dependent on the software and eventually diminishing writing mechanics like punctuation and spelling. Since the ESL context has no language input from the outer society, encounters and interaction with English language content are minimal. In such a context, modern technology offers an indirect path to obtaining English language content. Thus, potential software developments should address avenues to enhance language development. However, prolonged reliance on these tools can diminish student awareness of spelling and punctuation errors and delay the development of independent writing skills. Although the software enhances grammar and vocabulary accuracy, it fails to address stylistic and structural matters, which are crucial for academic writing. Moreover, informal language habits reinforced by frequent technology use can negatively impact academic writing quality. These findings suggest the need for balanced integration of technology in language education, emphasizing the importance of developing both technical accuracy and stylistic proficiency in ESL learners.

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