Shih, JL. et al. (Eds.) (2023). Proceedings of the 31st International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

Empowering Language Learners: Harnessing Computer-Based Writing for Enhanced Chinese Language Proficiency

Lung-Hsiang WONG[a*], Guat Poh AW[a], Wenli Chen[a], Yin Ling CHEUNG[a], & Seok Hwa SIM[b]

[a]*National Institute of Education, Nanyang Technological University, Singapore*
[b]*Curriculum Planning and Development Division, Ministry of Education, Singapore*
*lhwong.acad@gmail.com

Abstract: Computer-based writing (CBW) has become integral in language education, enabling personalised learning and online collaboration. In Singapore, CBW is being introduced in Chinese Language (CL) classes, yet challenges persist, particularly for students using the phonetic-based *pinyin* input method. This study investigated the impact of partially replacing paper-and-pen-based writing (PPBW) with CBW in primary schools. Using mixed-effects modeling, we compared post-CBW and post-PPBW scores, considering CL achievement levels. Results indicated CBW's positive influence on writing quality regardless of prior competence. Furthermore, CBW significantly benefits low and medium-achieving students' performance. Typing speed and handwriting speed are influential for these students, while different writing strategies play distinct roles. Informed by the findings, we propose an online writing community platform, WeeWrite, incorporating generative AI to enhance CL CBW skills, offering personalised and collaborative learning experiences.

Keywords: Computer-assisted language learning; Computer-based writing; Chinese as a second language; ChatGPT in language learning

1. Introduction

Computer-based writing (CBW) has become the primary mode of writing in our daily life. The proliferation of Information and Communication Technology (ICT) has also opened up opportunities for language students to leverage digital tools that can personalise their learning and join online collaborative learning communities with text-based communication. This implies the need for them to be adept in CBW skills to optimise their technology-enhanced learning experience and outcomes. In Singapore, CBW is gradually being infused into the Chinese Language (CL) classes in primary and secondary schools, as well as national examinations in secondary schools (Tushara, 2023). Yet the students, most having a second language (L2) standard, continue to grapple with the challenge of making the 'indirect' keyboard-based input method (the phonetic-based *pinyin*) an efficient alternative to paper-and-pen-based writing (PPBW). Furthermore, decades of comparative studies in CBW versus PPBW in L2 classrooms have yielded inconsistent findings on which writing mode would be more conducive for young students to produce writing of higher quality (Cheung, 2012). While we do not advocate a full replacement of PPBW with CBW in L2 classes, we see the need to infuse more CBW activities, not only to reflect the real-world use of CBW, but also to prepare students to communicate electronically when they grow up.

The purpose of this baseline study is to discover the conditions under which students can benefit from infusing more CBW in primary school classrooms. Conditions may vary for students with different CL achievement levels and characteristics. We intend to derive differentiated ICT-aided means from the research findings to support students of different profiles in improving CL CBW competences. Informed by the findings, we propose a design model of an online writing community platform, WeeWrite (We e-Write; "共写未来"). The

proposed platform will harness generative Artificial Intelligence (AI) and other advanced technologies to deliver writing pedagogy and facilitate individual, personalised and collaborative learning out of class.

2. Literature Review

2.1 Rationale and challenges for promoting CBW in language classes

E-writing is replacing PPBW to become our primary mode of writing (Li, 2006). Authoring for the purpose of connecting with people and sharing knowledge is becoming part of digital natives' way of life and they exert subtle influences on learners' holistic development (Greenhow et al., 2009). Thus, a necessary language pedagogical shift, without hindering the development of basic handwriting and PPBW skills, is to situate learners more intensively in the e-writing space (Bolter, 1991). However, as CL scripts are not based on the Latin alphabet system but are logographic, there are barriers for students to adopt the 'indirect' phonetic-based *pinyin* input method. The use of *pinyin* input requires L2 writers' additional mental processing (Xie, 2001), on top of the "double translation" effect (Wolfe & Manalo, 2004; Wong et al., 2011) where they may perform a mental translation from their first language to L2, and then translate from L2 into keystrokes.

2.1.1 Prior Studies on CBW versus PPBW for compositions in language classes

Prior research comparing CBW and PPBW in English Language (EL) classes has yielded inconsistent findings. The mixed results may be due to variations in sample sizes, students' age groups and language and computer proficiencies, task types and software used, etc. (Cheung, 2012). the quality of CBW compositions has been found to be higher than PPBW compositions in some studies (e.g., Bernhardt et al., 1989; Lam & Pennington, 1995; Li, 2006). Other researchers, however, have found no significant differences in this aspect (e.g., Burley, 1994; Dalton & Hannafin, 1987; Wolfe & Manalo, 2004).

Some studies collected (e.g., with screen capturing tools) and analysed the writing process data to unveil the students' writing patterns in both modes. For example, Li (2006) discovered that during PPBW, adult English as second language (ESL) learners spent more time in pre-planning; whereas for CBW, they carried out more higher-order thinking activities while evaluating their written texts. Zoghi and Reshadi (2013) unpacked ESL students' writing process and found that those engaged in CBW and PPBW did not show significant differences in the employment of rhetorical, metacognitive, cognitive, communicative and social/affective strategies. Yet students in the CBW group had tapped on the technological affordances to either perform certain productive strategies more frequently (e.g., formatting/modelling, which is made easy by the technology), or be offloaded from performing unproductive strategies (e.g., less rehearsing, due to the ease of editing). Elsewhere, focusing on analysing L2 learners' revision behaviour in CBW, Barkaoui (2016) discovered that it was L2 proficiency and task type, not keyboarding skills, that affected such behaviour. The subjects with low L2 proficiency performed more low-level (e.g., typographic) revisions at the expense of higher-level revisions.

Scattered research investigated student perceptions on CBW versus PPBW. For example, three studies focused on measuring the students' writing anxiety through administering Second Language Writing Anxiety Inventory (L2WAI) (Cheng, 2004) to their respective samples (college ESL students) in CBW and PPBW groups before and after the writing tasks. L2WAI encompasses three sub-components: cognitive anxiety (mental aspect of anxiety, i.e., negative expectations, preoccupation with performance, etc.), somatic anxiety (autonomic responses, i.e., nervousness and tensions), and behavioural anxiety (procrastination, withdrawal, and avoidance behaviour). Bailey et al. (2017) found that the students in the CBW group increased significantly in behavioural anxiety, and the students in PPBW group increased significantly in somatic anxiety, while there is no decrease in any form of anxiety. The results contradicted the findings of Kurt and Atay (2007), and Foroutan and Noordin (2012), which indicated significant decreases in such anxiety.

Compared to the abundant prior research in EL CBW, the research on Chinese CBW (particularly in comparison with those of PPBW) is relatively scarce. For example, Kang (2011) and Zhu et al. (2015) studied Chinese as Foreign Language college students in China respectively. Kang et al. (2011) found that CBW helped intermediate students more (compared to beginners) as they produced longer articles and in shorter time. Zhu et al.'s (2015) study, on the contrary, showed that CBW benefited students of low proficiency more as the scores and lengths of their CBW compositions were significantly greater than those of their PPBW compositions. Instead, the differences between the CBW and PPBW compositions written by students of high proficiency were not significant.

Again, all these conflicting findings have shown that the research evidence on CBW versus PPBW is context dependent. Thus, Chinese as L2 educators would be baffled should they consult the literature on how and to what extent they could employ CBW in writing classrooms. Our study is intended to overcome most of the limitations in the prior research, especially that our focus is on younger CL as L2 students.

3. Method

3.1 Participants and data collection

This study aimed to investigate the impacts of partially incorporating CBW compared to PPBW (status quo) in CL classes in primary schools in Singapore. The focus was to compare the effects of the writing media used, not the writing pedagogy. This was accomplished through measuring project participants' writing products and relevant perceptions. 127 Primary 5 (11-year-old) students from four public primary schools participated in this study. All students began writing full compositions with paper and pen in CL classes a year ago. Yet they had no prior experience in writing full compositions on computer. The research questions (RQs) are:

(RQ1) What is the comparative performance of students in the post-CBW test when accounting for the influence of the pre-CBW test?

(RQ2) Is there a significant performance disparity between the students' post-CBW test and their post-PPBW test?

(RQ3) What factors predict the post-CBW scores of high-achieving (HA), medium-achieving (MA), and low-achieving (LA) students, regardless of the treatment conditions?

Three types of data were collected over one academic year, namely, CL compositions, pre- and post-surveys, and computer writing and handwriting speed tests.

(1) CL compositions

We tapped on regular CL in-class composition sessions to collect CBW and PPBW artefacts across an entire year. The participating students were randomly assigned to two treatment groups with varied ratios of CBW and PPBW sessions, namely, **(G1)** 5 CBW + 3 PPBW sessions; **(G2)** 3 CBW + 5 PPBW sessions. The total number of students (randomly) assigned to G1 and G2 across the participating schools were 63 and 64 respectively. Notebook computers with Microsoft Word installed were used for the sessions. All schools conducted each writing session for 50 minutes, with the task type (pictorial compositions / narrative essays) and teacher scaffolding designs modelled on the national CL syllabus. However, as each school has its own school-based elements in their writing curriculum, we were not able to control their writing prompts (the pictures) across the sessions.

To mitigate the order effect, the PPBW and CBW sessions in each group were evenly spread across the academic year. The first and the last (eighth) sessions were PPBW sessions and were treated as pre-PPBW and post-PPBW tests respectively. The second and the seventh sessions were CBW sessions and were treated as pre-CBW and post-CBW tests respectively. We randomly selected 10% (52) of the compositions collected from these four sessions and asked two raters (who were retired CL master teachers) to score them independently using a validated rubric derived from the Ministry of Education's teachers' guide to primary school CL curriculum. Each composition was scored by the following dimensions (in the Likert scale of 1 (poor) to 5 (excellent)): material, theme, narration, grammar, structure, and vocabulary. Interrater reliabilities were then computed, with the

absolute agreement average measures of intraclass consistency coefficients (ICC) ranging from .86 to .90 (i.e., all >.75), indicating excellent reliability across all dimensions (Cicchetti, 1994). The rest of the compositions were divided in half and assigned to the raters to score.

(2) Pre- and post-surveys

All participants were administered pre- and post-surveys before the first writing session and after the last writing session respectively. The survey, in a Likert scale of 1 to 5, combines three validated instruments, namely, Motivation and Learning Strategy Questionnaire (MSLQ) (Pintrich et al., 1991) (to measure their intrinsic goal orientation, extrinsic goal orientation, and task value in CL writing), L2 Writing Anxiety Inventory (L2WAI) (Cheng, 2004) (to measure their cognitive anxiety, somatic anxiety, and avoidance behaviour in CL writing), and Writing strategy questionnaire (Bai et al., 2014) (to measure their frequencies of applying planning, monitoring/evaluation, revising, text-generating, and resourcing strategies in their CL PPBW). There are additional items the in post-survey to measure their strategies in CL CBW.

(3) Pre- and post-computer input or handwriting speed test

All participants were administered pre- and post-CL input speed tests and EL input speed tests. The EL input speed is a proxy for their general keyboarding speed as EL typing is more direct, compared to the indirect *pinyin* input. In each test, they were required to copy a recently taught CL or EL textbook passage. The time limit of each test was two minutes. The correct number of Chinese character or English words input per minute was determined.

Furthermore, we are interested in identifying the varied conditions that may affect HA, MA and LA students' post-CBW test scores. The results may derive differentiated, personalised writing instruction for each student band. Thus, we used the pre-PPBW score as a proxy for their CL writing achievement level and divided them into the three bands (HA – 39 students; MA – 48 students; LA – 40 students; the uneven student counts are due to the same scores of "borderline" students).

3.2 Data analysis

For the statistical analysis, the post-CBW test scores are the dependent variable to address all three RQs. The pre-CBW scores are the covariate to address RQ1. The post-PPBW scores are the predictor to address RQ2. All the variables related to the pre- and post-survey and speed tests are predictors to address RQ3.

Mixed-effects modeling (Laird & Ware, 1982) was used for most of our analyses. Compared to traditional approaches such as *t*-test and ANCOVA, mixed-effects modelling is more flexible as we can combine and analyse data collected from multiple schools into a single model while accounting for the inherent variability and dependencies within each school. In essence, a mixed-effects model consists of fixed effects and random effects. Fixed effects represent the variables that are of primary interest in our analysis, while random effects capture the variability across the different schools. In addition, we performed stepwise regression analysis to determine the best fit models of the three student bands.

4. Findings and Preliminary Discussion

4.1 Comparison of pre- and post-test scores (to address RQ1 and RQ2)

We performed mixed effects modelling on the pre- and post-CBW scores and the post-PPBW score in place of paired *t*-tests or ANCOVA to account for the school factor as the random effects. Tables 1 and 2 show the descriptive statistics and the results of the analyses respectively. Due to the space limit, only the *t*-values or the *F*-values, and the statistical significance of the score differences, are presented in Table 2. We excluded pre-PPBW test score from the analysis as it was only treated as the proxy for the students' prior CL competence and was used for dividing them into the three bands.

Table 1. *Descriptive statistics (mean (standard deviation))*

	All students	G1	G2	HA	MA	LA
Pre-CBW	16.44 (4.68)	16.64 (4.48)	16.24 (4.90)	20.13 (3.47)	16.56 (3.77)	12.70 (3.71)
Post-CBW	17.69 (3.81)	17.91 (3.32)	17.46 (4.26)	20.33 (3.56)	17.75 (2.56)	15.03 (3.52)
Post-PPBW	17.11 (3.34)	17.06 (3.64)	17.02 (3.23)	18.85 (2.93)	17.25 (2.73)	14.89 (2.89)

Table 2. *Mixed effects modeling analyses to compare the test scores*

	Comparison of the two scores within each group/band (*t*-value)						Comparison of the two scores across groups or bands (*F*-value)	
	All students	G1	G2	HA	MA	LA	G1 vs G2	HA vs MA vs LA
Pre- vs post-CBW	13.308**	10.042**	12.406**	4.413**	6.770**	5.445**	.855	.477
Post-CBW vs post-PPBW	-1.488	-.912	-1.848	-.825	-2.250	-1.700	.967	27.167**

** p<.05; ** p<.001*

According to Table 2, all students improved significantly in the post-CBW scores compared to the pre-CBW scores, regardless of treatment conditions/groups, or student bands. No significant difference was observed when comparing post-CBW score across the groups or bands while controlling for their pre-CBW score.

On the contrary, there was no significant difference in the students' post-CBW and post-PPBW scores across the treatment conditions or student bands. When comparing post-CBW scores across treatment groups, no significant difference was found either. However, a significant difference emerged when comparing post-CBW scores across student bands. A post-hoc test of pairwise comparison with Bonferroni correction indicates that the HA students showed a significantly larger difference in scores between post-CBW and post-PPBW compared to both MA and LA students. Additionally, LA students exhibited a significantly greater difference in scores between the two tests than the MA students.

These findings seem to contradict early common assumptions that the "unnatural" CL typing would hinder beginners' CL writing performance and writing skill development (Zhang, 2021). By the end of the study, we not only observed students' significant improvement in their CBW writing regardless of their prior CL competences and CL typing experience, they produced CBW and PPBW artefacts with similar quality. Henceforth, the concern about the possible detrimental effect on students' writing development of partially replacing PPBW with CBW in CL classes may be less pertinent.

4.2 The predictors of post-CBW scores of individual student bands (to address RQ3)

We conducted stepwise regression analyses to yield the best-fit models for predicting post-CBW scores within each student band. Due to the space limit and for ease of comparison, we present the three models in Table 3 in a summarising view.

Table 3: *Best-fit models for predicting post-CBW scores within each student band (t-values)*

	HA	MA	LA
Pre-CBW score	2.524*	5.074**	3.652*
Pre-PPBW score			-3.120*
Post-PPBW score		4.109**	10.125**
CL typing speed		2.648*	
CL handwriting speed			10.760*
Somatic anxiety (post-survey)	-9.402*		
Avoidance behaviour (post-survey)	-3.737*		
Planning strategies in PPBW (post-survey)		2.723*	
Planning strategies in CBW (post-survey)			-6.601**
Monitoring/evaluation strategies in PPBW (post-survey)	5.009**		
Text generation strategies in CBW (post-survey)		4.476**	
Resourcing strategies in CBW (post-survey)			8.244**

** p<.05; ** p<.001*

Based on the respective predictor sets of the three models, we determined the characteristics of the students' CL competences in each band, which are triangulated by the

feedback from participating CL teachers of the study and our own extensive relevant experience and observations (three of the co-authors are educational researchers and teacher educators with vast experience in conducting school-based research in authentic CL classes; two of them are former teachers).

4.2.1 The CL typing speed and handwriting speed

Do the students' CL handwriting and typing speeds affect their CBW performance? According to the models, both variables did not predict HA students' post-CBW scores, while MA and LA students' post-CBW scores were positively predicted by their CL typing speed and handwriting speed respectively. The plausible explanation is as follows.

For HA students, the switching of writing modes did not affect their general CL writing performance – they were likely to perform equally well when writing in both modes.

For LA students, based on the teachers' feedback and our team members' experience, we posit that they were generally weaker in vocabulary, grammar and content development. Furthermore, they often encountered the challenges of recalling the visual structure of individual CL characters to handwrite, after subvocalising the text internally (i.e., silently articulating the text in their mind, simulating the act of speaking without vocalising words aloud). We posit that these were likely to be the more prominent factors affecting their writing performance compared to their CL typing speed. The handwriting speed as a predictor of their CBW performance is seemingly counter-intuitive. Yet this can be explained as follows: slower handwriting speed may indeed reflect their difficulties in both composing the text in their heads and recalling character 'shapes'.

For MA students, their CL typing speed did matter. A possible reason is that they also faced the difficulty of recalling character 'shapes', whereas their overall linguistic skills were stronger than LA students (i.e., less challenging in subvocalising the text before transcribing it on computer). During CBW, pinyin input did help them get around the former difficulty.

Henceforth, we posit that switching to CBW would benefit both LA and MA students more in terms of producing higher quality written artefacts. The key is to provide them with further training in CL typing. We posit that if they are more adept at CL typing, their cognitive load in recalling character 'shapes' could be reduced. They could then devote more cognitive effort to subvocalising the text when writing (or developing the skills to do so). LA students are generally also weaker in the *pinyin* scheme. Additional training is needed in this area. For HA students, CL typing training may also be helpful, but need not be the focus.

4.2.2 The writing strategies

In both the pre- and post-surveys, students were asked to indicate the frequency with which they used planning, monitoring/evaluation, resourcing, revising, and text generation strategies in PPBW. In the post-survey, they also indicated the frequency with which they used these strategies in CBW. Our analysis showed that not all the strategies could predict their post-CBW scores.

The frequency of using resourcing strategies (checking e-dictionary or other language references when encountering difficulties in writing) during CBW positively predicted LA students' scores. In Singapore's CL composition classes and examinations, students are allowed to check e-dictionary. Resourcing strategies as a predictor could mean that some LA students did not bother to make good use of the e-dictionary to compensate for their linguistic deficits, thus affecting their CBW performance.

The frequency of using text generation strategies (recalling segments of text or content ideas in other reading materials for use in their own writing) during CBW positively predicted MA students' scores. There is indeed a writing strategy known as "utilising impressive phrases and sentences" （好词好句） which has been a common strategy promoted by many Singapore primary CL teachers for composition writing. Some students deliberately memorise such phrases/sentences from other sources for this purpose. While we are cautious about using this strategy in the long term, we recognise that it is helpful for beginners, as it can be seen as a basis for imitation and modelling before they gain

confidence and move on to producing text largely in their own words. Combining this finding with the discussion of MA students' challenges in PPBW in section 4.2.1, we posit that MA students who produced better CBW articles may have had prior knowledge of writing, such as “impressive phrases and sentences”, but were not confident in handwriting them because of the difficulty of retrieving the character 'shapes'. Switching from PPBW to CBW would optimise the effect of text generation strategies, as they would retrieve characters by pronunciation through *pinyin* input, which is directly linked to their subvocalised text.

A surprising finding is that the frequency of applying planning strategies (e.g., outlining, thinking or discussing with others before starting to write) in CBW negatively predicted LA students’ post-CBW scores. A possible explanation is that LA students’ ability to comprehend the writing instructions and the writing prompts (pictures for pictorial composition) is weaker. Thus, those who used the strategies tended to plan for content that was off-topic or of lower linguistic quality.

Two PPBW strategies emerged as predictors of post-CBW scores (planning strategies for MA students, and monitoring/evaluation strategies for HA students). We suspect that this is because the students filled out the PPBW-related survey items before the CBW items, and some of them did not consciously distinguish between the strategies they used in PPBW and in CBW. With the expectation that the PPBW strategies can be transferred to CBW when students are given more CBW opportunities, we can assume that these strategies are also conducive to CBW for the respective student bands.

All in all, the five categories of strategies could be effective for improving writing quality if they are properly used. However, it may be a tall order for young students to pick all of them up at once. Our findings might suggest strategies to prioritise the development of these strategies for students of different bands – monitoring/evaluation strategies for HA students, planning strategies and text generation strategies for MA students, and resourcing strategies for LA students. Also, given that some LA students may need to be rectified in their planning strategies (as these are a negative predictor), it may also be beneficial to provide explicit coaching to LA students to help them use such strategies in the right way.

4.2.3 Other predictors (and non-predictors)

Somatic anxiety (e.g., nervousness and tensions) and avoidance behaviour in CL writing negatively predicted the post-CBW scores of HA students, but not students in other bands. However, cognitive anxiety (e.g., worrying about being evaluated or getting bad grades), related to the anxiety caused by extrinsic goal orientation, did not predict the scores. The three learning motivation subscales taken from the MSLQ instrument, namely, intrinsic goal orientation, extrinsic goal orientation, and task value in CL writing, also did not predict scores. Thus, the students’ level of motivation to learn CL writing might not have played a notable role in their CBW performance.

The group factor (with varying numbers of CBW sessions over the year) is not a predictor of the post-CBW scores of any student band. This finding echoes the results of our analysis in section 4.1, implying that the assumption that "(more) practice makes perfect (better scores)" does not hold. It is more important to practice under the right conditions - and these conditions should be determined holistically, for example through our analyses to identify the right combination of predictors of eventual CBW performance.

5. Proposed design model for an online writing community platform

Informed by our findings, we propose a design model for an online writing community platform known as WeeWrite （共写未来）. We envision an online learning environment that provides systematic coaching and opportunities for CL e-writing for communication. The proposed platform will harness generative AI (particularly chatbots empowered by Large Language Models (LLMs)) and other technologies to deliver writing pedagogy and facilitate personalised and collaborative learning.

The WeeWrite design model consists of a personal learning space and a social learning space. A natural class of students (or beyond) can form a learning community, which is configurable by their teacher. When a student registers for an account, a chatbot known as MeWrite pal is created for them, and will keep them company when they stay on the platform. The MeWrite pal is an educational version of an LLM-empowered chatbot such as ChatGPT, which is reconfigured to be proactive in coaching and supporting the student to learn and e-write in the platform (rather than ChatGPT or alike which always “sit back” and wait for user’s next prompt), and providing instant evaluation on their e-writing. Furthermore, it is reconfigured in the way that it will only respond to student’s prompts written in CL (with a grace period at the beginning which allows students to occasionally “switch code” to EL while building their motivation to stay in the environment), and might refuse to entertain certain types of student requests which do not conducive to their learning of e-writing, such as auto-generating a composition from scratch.

The personal learning space is meant for the student to be coached in various skills involved in e-writing and for them to draft their e-essays or e-messages with the MeWrite pal’s guidance or support. For example, amid the student’s e-writing process, the MeWrite pal could recommend relevant words to include based on the writing context (akin to such affordances in Microsoft Office CoPilot) – this can be considered as an automated version of **text generation strategies**, which may be most beneficial to MA students according to our findings. Yet such recommendations should not be too frequent (or they will prevent the student from developing the ability to e-write in their own words) and should be treated as a scaffold that should fade out when the student’s e-writing competence has improved.

Furthermore, various e-coaching modules for the pinyin scheme, CL typing, and the five types of writing strategies will be developed and incorporated into the platform. Yet they will be activated by the MeWrite pal to the student based on different priorities and orders according to the student’s band (given the implications drawn in section 4.2, informed by our findings). For example, a LA student might first be tested in **the *pinyin* scheme and CL typing speed**. If the results indicate that additional coaching and practice are needed, the MeWrite pal will activate the corresponding e-coaching packages. Next, the student will be coached in **resourcing strategies** (and the coaching package will be linked to an online dictionary with the same content as the e-dictionary device they use in their physical composition sessions) and followed by **planning strategies** in e-writing. For example, they might be asked to draft a short email by applying specific strategies, and instant formative feedback on their draft (e.g., in terms of the six criteria in the rubric we used for scoring student compositions in our study) will be given; and they will be encouraged to improve it accordingly. Additionally, the MeWrite pal could be their vocabulary and grammar coach, helping them catch up with their peers in other bands in these areas.

For MA students, the learning pathway could start with **CL typing**, followed by **text generation** and **planning strategies**. For HA students, the initial focus could be placed on **monitoring/evaluation strategies**.

Depending on their learning progress, all students may eventually be coached in all strategy types, but the learning pathways could be personalised. Furthermore, as HA students are adept at e-writing as suggested by our findings, we advocate going one step further by developing their critical and creative e-writing skills – which can be guided by the meWrite pal with more advanced coaching modules.

Social learning activities can take place and be intertwined with individual learning tasks. Students can enter the social learning space at any time to read and comment on their peers’ e-writing. They can create and share social media, perhaps with a requirement to use certain target words or sentence structures, or on certain topics – such requirements could be set by the teacher to link to the formal teaching; and the requirements would be delivered by the MeWrite pal to individual students. Furthermore, after being evaluated by the MeWrite pal, students' practice write-up in their individual spaces may be selected for sharing in a special spotlight bulletin in the social space. The goal is to foster their sense of pride and create a 'reader effect' that encourages them to further enhance their e-writing skills. The MeWrite pal may also alert the student to check the social learning space when there are interesting posts or teacher-facilitated collaborative e-writing events going on.

The proposed online platform is not meant to replace the formal writing instruction in CL lessons but to complement it. It serves the purpose of extending the students' learning to e-write beyond the school sessions, and offering more opportunities for students to access a greater range of ICT affordances, many of which are adaptive, thus facilitating self-directed and personalised learning (as well as collaborative learning in the social learning space). We envisage that such a platform will realise what the **negative predictors of "avoidance behaviour" and "somatic anxiety"** imply, as the environment is low-stakes – their e-writing products on the platform are not formally assessed, and they have no time pressure to write, unlike in time-limited class composition sessions or examinations.

6. Conclusion and future directions

This study advances our understanding of the impact of incorporating CBW in CL education and sheds light on the varying conditions under which students benefit from such integration. Our findings suggest that CBW can significantly improve writing quality, challenging traditional assumptions. For MA and LA students, enhancing CL typing skills is crucial to harness CBW's potential. Different writing strategies are vital for distinct student bands, offering a roadmap for targeted instructional strategies.

Moreover, our proposed design model for WeeWrite as an online writing community platform capitalises on advanced technologies, particularly generative AI, to provide a personalised and collaborative learning environment. By leveraging AI-driven chatbots, students can engage in continuous practice, receive real-time feedback, and collaborate with peers. This platform aligns with the 21st-century learning landscape, fostering CL CBW competences that extend beyond the classroom.

The study, however, is not without limitations. Firstly, it was conducted within specific schools in Singapore, resulting in relatively limited sample sizes when the subjects were split into the three student bands for analyses. Factors beyond our scope, such as variations in teaching methods, teacher expertise, and students' individual writing practice outside class, were not addressed. Thus, the generalisability of the findings may be constrained, both in terms of the research context and the extent to which the results can be extrapolated.

Moreover, the study did not control the writing prompts, which could have exerted diverse influences on students' performance. A critical challenge arose from the reluctance of participating schools to relinquish their school-based components of the writing curriculum. This precluded us from controlling year-round composition sessions. The schools would likely have shown greater willingness to follow our design if data collection were confined to one or two CBW sessions.

Nonetheless, the study's merits lie in demonstrating that young students can perform well in both CBW and PPBW given exposure to the former. As a result, future investigations should shift their focus from comparing CBW and PPBW to exploring the conditions (predictors) conducive to improved CBW performance. Instead of pursuing longitudinal interventions, an alternative approach could involve a substantially larger sample size, encompassing students with varying levels of competence in CL typing or CBW skills, across more schools. This modified strategy, incorporating only one or two rigorously controlled composition sessions, would circumvent schools' resistance to year-round control. Such an approach would offer an avenue to verify or refine our findings concerning the optimal conditions for enhanced CBW performance among different student bands.

References

Bai, R., Hu, G., & Gu, P. Y. (2014). The relationship between use of writing strategies and English proficiency in Singapore primary schools. *Asia-Pacific Education Researcher*, *23*(3), 355-365.

Bailey, D. R., Lee, A. R., Vorst, T. M., & Crosthwaite, P. (2017). An investigation of differences and changes in L2 writing anxiety between blended and conventional English Language learning context. *CALL-EJ*, *18*(1), 22-39.

Barkaoui, K. (2016). What and when second-language learners revise when responding to timed writing tasks on the computer: The roles of task type, second language proficiency, and keyboarding skills. *The Modern Language Journal*, *100*(1), 320-340.
Bernhardt, S. A., Wojahn, P. G., & Edwards, P. R. (1989). Teaching college composition with computers: A timed observation study. *Written Communication*, *6*, 108-133.
Bolter, D. (1991). Topographic writing: hypertext and the electronic writing space. In P. Delany & G. Landow (Eds.), *Hypermedia and Literary Studies* (pp. 105-118). MIT Press.
Burley, H. (1994). *Postsecondary novice and better than novice writers: The effects of word processing and a very special computer assisted writing lab* Southwestern Educational Research Association Meeting, San Antonio, TX.
Cheng, Y. S. (2004). A measurement of second language writing anxiety: Scale development and preliminary validation *Second Language Writing*, *13*, 313-335.
Cheung, Y. L. (2012). Critical review of recent studies investigating effects of word processing-assisted writing and pen-and-paper writing on the quality of writing and higher level revisions. *Procedia - Social and Behavioral Sciences*, *46*, 1047-1050.
Cicchetti, D. V. (1994). Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychological Assessment*, *6*(4), 284-290.
Dalton, D. W., & Hannafin, M. J. (1987). The effect of word processing on written composition. *Journal of Educational Research*, *80*, 338-342.
Foroutan, M., & Noordin, N. (2012). Effect of dialogue journal writing through the use of conventional tools and e-mail on writing anxiety in the ESL context. *English Language Teaching*, *5*(1), 10-19.
Greenhow, C., Robelia, B., & Hughes, J. E. (2009). Web 2.0 and classroom research: What path should we take now? *Educational Researchers*, *38*(4), 246-259.
Kang, H. (2011). *Computer-based writing and paper-based writing: A study of beginning-level and intermediate-level Chinese learners' writing* The Ohio State University]. Columbus, USA.
Kurt, G., & Atay, D. (2007). The effects of peer feedback on the writing anxiety of prospective Turkish teachers of EFL. *Journal of Theory and Practice in Education & Treatment of Children*, *3*(12-23).
Laird, N. M., & Ware, J. H. (1982). Random-effects models for longitudinal data. *Biometrics*, *38*(4), 963-974.
Lam, F. S., & Pennington, M. C. (1995). The computer vs. the pen: A comparative study of word processing in a Hong Kong secondary classroom. *Computer Assisted Language Learning*, *8*, 75-92.
Li, J. (2006). The mediation of technology in ESL writing and its implications for writing assessment. *Assessing Writing*, *11*, 5-21.
Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ)*. University of Michigan, National Center for Research to Improve Postsecondary Teaching and Learning.
Tushara, E. (2023). Laptops replace pen and paper as S'pore shifts towards electronic examinations. *The Straits Times*. https://www.straitstimes.com/singapore/laptops-replace-pen-and-paper-as-s-pore-shifts-towards-electronic-examinations
Wolfe, E. W., & Manalo, J. R. (2004). Composition medium comparability in a direct writing assessment of non-native English speakers. *Language Learning & Technology*, *8*(1), 53-65.
Wong, L.-H., Chai, C.-S., & Gao, P. (2011). The Chinese input challenges for Chinese as second language learners in computer mediated writing: An exploratory study. *The Turkish Online Journal of Educational Technology*, *10*(3), 233-248.
Xie, T. (2001). *The digitalization of Chinese teaching and learning: The use of vocabulary processing software and its impact in teaching and learning* International Conference on Internet Chinese Education 2001, Taipei, Taiwan.
Zhang, P. N. (2021). Typing to Replace Handwriting: Effectiveness of the Typing-Primary Approach for L2 Chinese Beginners. *Journal of Technology & Chinese Language Teaching*, *12*(2), 1-28.
Zhu, Y., Shum, S.-K. M., Tse, S.-K., & Liu, J. J. (2015). Word-processor or pencil-and-paper? A comparison of students' writing in Chinese as a foreign language. *Computer Assisted Language Learning*, *29*(3), 1-22.
Zoghi, M., & Reshadi, E. (2013). Computer-based vs. paper-based writing tests: A comparative study of test taking strategies. *International Journal of English Language Education*, *1*(3), 43-56.