

Machine Translation Errors and L2 Learners' Correction Strategies by Error Type and English Proficiency

Chae Won Yoon and Yuah V. Chon*

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To investigate L2 adolescent learners' use of machine translation (MT), an MT error correction (EC) test was developed, based on the analysis of MT errors arising from translating the learners' L1 of middle school EFL textbooks. Learners were also asked to report on their use of MT EC strategies on the EC task. Results indicated that *mistranslated sentence* and *verb tense* are the most difficult types of MT errors to correct. Furthermore, to resolve MT errors, *guessing from context* and *literal translations* were the two most frequently employed EC strategies. When multiple regression analysis was conducted to examine the contribution of EC strategies to the learners' ability to correct errors, the mid proficiency learners' reliance on literal translations and the low proficiency learners' use of multiple EC strategies were positively associated with improved corrections of MT errors. The results of the study are discussed in light of how L2 learners need to develop competence for using MT in L2 writing.

Key words: machine translation, error correction strategies, L2 writing

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*First Author: Chae Won Yoon, Graduate Student, Department of English Education, Hanyang University
Corresponding Author: Yuah V. Chon, Professor, Department of English Education, Hanyang University; 222, Wangshimli-ro, Seongdong-gu, Seoul 04763, Korea; Email: vylee52@hanyang.ac.kr

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1. INTRODUCTION

With the recent emergence of artificial intelligence (AI), “translation has become an integral part of the communicative landscape in the personal and academic lives of many people” (Clifford, Merschel, & Munné, 2013, p. 109). Utilization of AI in educational contexts involves machine translation (MT)—an increasingly reliable source of reference for second language (L2) writing (Ducar & Schocket, 2018; Groves & Mundt, 2015, 2021). The introduction of neural MT with *Google Translate* (GT) since 2016 has motivated language learners to use it when their knowledge of L2 may be insufficient for L2 writing. Neural MT applies a large artificial neural network for predicting the likelihood of a sequence of words, typically in the form of sentences. Unlike statistical MT—consuming more memory and time—neural MT trains its parts end-to-end to maximize performance (DeepAI, 2019). Hereafter, the terms MT and GT will be used interchangeably throughout the study.

Recent research on the use of MT with L2 learners has focused primarily on tertiary level learners aiming to assess the quality of machine-translated output (Cancino & Panes, 2021; Chon, Shin, & Kim, 2021; Groves & Mundt, 2015; Wallwork, 2016) and analyze L2 learners’ perceptions (Ahn & Chung, 2020; Alhaisoni & Alhaysony, 2017; Briggs, 2018; Jolley & Maimone, 2015; Murtisari, Widiningrum, Branata, & Susanto, 2019) and teachers’ perceptions (Clifford et al., 2013; Correa, 2011; Groves & Mundt, 2021; Niño, 2009; Stapleton & Kin, 2019) of using MT for L2 writing. However, research is lacking in terms of how L2 learners correct errors that appear in the raw MT output; that is, successfully using MT includes the ability to notice MT errors and post-edit erroneous parts of the MT output (Kol, Schcolnik, & Spector-Cohen, 2018) pertaining to editing or revising the output (Yamada, 2015). Moreover, although English as a foreign language (EFL) middle school learners are typically digital natives who are expected to become avid users of MT for both learning and vocational purposes, studies are rare on how they may correct MT errors when conducting L2 writing.

Given the above, an MT error correction (EC) task was developed by analyzing the types of errors that occur when learners’ L1 of reading passages of middle school EFL textbooks was machine-translated to English. Error samples demonstrative of different types of errors were used to develop EC items, and the learners were asked to report on their use of EC strategies to explore their EC. As such, the present study aimed to examine L2 learners’ ability to correct MT errors regarding the error type and learners’ L2 proficiency.

2. BACKGROUND

Early MT studies viewed MT as sources of errors, particularly lexico-grammatical errors that required corrections through post-editing (i.e., comparing a source text with the MT and making changes for both meaning and language to make it acceptable for its intended purpose). The post-editing process has been explored by Belam (2002), Kliffer (2005), and Niño (2008). Belam (2002) describes the use of an assessed independent study project on MT evaluation in a language teaching course in which students were asked to describe the type of evaluation they focused on during the MT output (e.g., accuracy, readability, coherence) and examine practical problems (e.g., how much text needs to be pre- or post-edited to arrive at an acceptable translation). These tasks allowed the students to increase their linguistic awareness. Kliffer (2005) describes an experiment to introduce MT via post-editing to university students for French-to-English translations. The post-editing of the three different proficiency groups resulted in the reduction of total frequency of errors, but the spread of scores among the three groups was large (i.e., 118, 53 and 12 errors for the weak, average and strong students respectively). For weak and average students, word choice (occurring due to polysemy and homonymy) and literal translations were the most common error categories. Niño (2008) asked EFL students to post-edit a raw MT output by consulting different online resources; students used post-editing strategies such as rewriting, paraphrasing, self-correction, guessing, inferencing, reflecting, and employing synonyms.

More recent studies have been conducted to examine the possibility of using MT as a reference tool for L2 writing. White and Heidrich (2013) administered a task in which students translated from their L1 to the L2 (English to German), followed by providing options to learners to edit their work for suitability to accurately translate into German using the MT. The results indicated a reduction in the number of errors except in the subcategories for tense, conjugation, and declension. Groves and Mundt (2015) aimed to examine text translated from Malay and written Chinese through GT into English. With grammatical accuracy as the frame of analysis, the GT was found to produce more grammatically correct English from Malay than from Chinese. According to Wallwork (2016), in the translations from Italian to English, GT caused errors in word order, word forms (plural -s on acronyms, un/countable nouns), and misuse of tenses. Stapleton and Kin (2019) asked L2 primary students to write in English for the first task. In another task, students wrote in their native Chinese to the same prompt and subsequently translated the text into English using MT. When teachers were asked to grade grammar, vocabulary, and comprehensibility of these parallel essays, MT was found to be significantly better than non-MT writing in grammar. Lee and Lee (2021) adopted a qualitative approach toward analyzing how eight EFL university and graduate students exploited MT in completing a narrative essay. The learners were found to use the MT to search target English expressions that they did not know in L1,

search for alternative expressions for the English expressions that they were unsure of, and confirm the meaning of English expressions retrieved by the learners. Kol et al. (2018) conducted a case study, including two writing tasks: one with GT and one without. The results showed that when using GT, students wrote considerably more words. They wrote longer sentences with longer words, with an improved vocabulary profile. Lee and Briggs (2021) examined ECs made by university students by comparing their original L2 texts to that of MT output, indicating that the MT had mostly helped students to correct errors in articles, prepositions, noun plurals, and substitutions. Cancino and Panes (2021) conducted a study with EFL high school learners who were randomly assigned to one of three groups—GT without instruction, GT with instruction, and a group with no access to GT—showing that syntactic complexity and accuracy scores were higher in groups with access to MT compared to those without access to the tool. Chung and Ahn (2021) examined how L2 learners' use of MT affects syntactic complexity, accuracy, lexical complexity, and fluency in L2 writing. Text analysis of students' writing revealed major improvements in accuracy but unclear benefits in syntactic and lexical complexity. Furthermore, using MT helped learners increase their lexical variation but led to lower scores in lexical sophistication, suggesting that MT was recommending a wide range of common and frequently-used vocabulary.

The MT may also assist L2 learners whose linguistic knowledge is incomplete to write on their own, and L2 proficiency has been found to have an effect on the use of MT. Lee (2020) studied the impact of using MT on EFL students' writing by asking them to translate Korean into English without using MT and later correct their English writing using MT. The students' writing outcomes revealed that using MT was more beneficial for lower-level learners, who made fewer lexico-grammatical errors and produced improved revisions. Chung (2020) investigated how L2 proficiency affects the degree to which EFL university students can discern the accuracy of the MT output and whether proficiency affects the post-editing process. With increasing proficiency, the number of corrections increased, especially above the word level, and significant group differences could be found in the post-editing patterns of the MT text. Chon et al. (2021) asked EFL university learners to produce compositions for direct writing, self-translated writing, and machine-translated writing. The results indicated that the less skilled learners, with the MT, were able to write at a level beyond their current L2 writing proficiency. The researchers surmised that GT may have reached a stage that will allow users to produce better written texts than those produced by direct writing.

Thus, MT is increasingly becoming a reliable source of reference for L2 writing, as validated by previous studies. Nonetheless, there are few studies that highlight the importance of noticing MT errors and knowing how to correct them for successfully using MT. Moreover, studies rarely provide a systematic evaluation of L2 learners' ability to correct MT errors when they are required to solve different types of errors. What is more

blatantly absent is research on how adolescent learners (aged 14–16 years old) of L2 solve MT errors, and how they may (not) be confident about their performance in correcting MT errors. In short, their ability to use MT and the skills they adopt demand further investigation to provide a pedagogical framework for teaching L2 learners to use MT. The following research questions guided our study:

- 1) How well can EFL middle school learners correct MT errors, by error type and level of English proficiency?
- 2) How do EFL middle school learners use MT EC strategies, according to their level of English proficiency?
- 3) What are the types of EC strategies that lead EFL middle school learners to successfully correct MT errors, according to their level of English proficiency?

3. METHOD

3.1. Participants and Context

Ninety-seven (50 girls, 47 boys) third-year, EFL middle school students from the Gyeonggi province in South Korea participated in the study. They had been learning English from their third year of elementary school from the age of 10, and their ages were 15–16 at the time of the study. When asked in a background questionnaire, most of the learners (86.6%, $n = 84$) reported that they had used the MT for their school's performance-based assessment and homework from after-school private institutes. Among the learners who had used the MT, more than 50% reported that they had used it to search for unknown vocabulary while others (16.5%) reported having used it to check on translations between Korean (L1) and English (L2).

3.2. Training Session

A training session was conducted with learners as a group and its aim was to familiarize students with MT as a digital tool for L2 writing. The session was conducted for 40 minutes by two teachers in each of their classes. The teachers had 10 and seven years of experience in teaching EFL, respectively, and were familiar with the use of MT as a writing tool.

The training session consisted of activities in which the learners were asked to correct erroneous parts of the MT output through comparison with the source text (L1). The learners were also asked to become familiar with the MT EC test to be used as the main instrument

for data collection in the study.

3.3. Instrument

3.3.1. Machine Translation Error Correction Test

To gauge the learners' ability to correct MT errors, an MT EC test was developed in two stages. Stage one consisted of finding MT errors and analyzing the types of errors that can occur when translating between Korean (source text) and English (target text). English middle school learners' textbooks (Year 3, 13 publishers; 39,611 words) authorized by the Korean Ministry of Education and in line with the 2015 Korean National Curriculum of English were used for this analysis; Korean translations (learners' L1) available from the official teachers' manual were accessed. The source text was entered in GT to access the MT output. In the study, GT instead of Naver Papago was chosen to expose learners to a wider range of MT that is used in the global context. For analyzing the types of MT errors, previous taxonomies of MT errors were referenced (Chon et al., 2021; Costa, Ling, Luís, Correia, & Coheur, 2015; Ferris, 2011; Moorkens, 2018). For instance, Moorkens (2018) presents four types of MT errors, which can arise from *word order*, *mistranslations*, *omission*, and *addition*. Our categorization of MT errors occurred due to *mistranslations*, *ungrammaticality*, *word order issues*, *missing words*, and *mechanics*. However, considering the relative mean frequency and the gravity of the errors, MT errors occurring from *mistranslations*, *ungrammaticality*, and *word order* were selected for item development (see Table 1 for frequency of MT errors).

Mistranslations further occurred at the level of *words*, *phrases*, and *sentences* (see Appendix A). A mistranslated word error occurs when a single word item in the MT output (L2) is incorrect vis-à-vis the source text (L1). Similarly, a *mistranslated phrase* error and a *mistranslated sentence* error occur when a phrase and sentence, respectively, in the MT output are mistranslated in comparison with the source text. However, a *mistranslated sentence* error may require MT users to analyze the context (preceding and succeeding sentences) for accurate correction. *Ungrammaticality* consisted of errors occurring due to *wrong tense*, *singular/plural agreement* for nouns/verbs, and *wrong part of speech*. *Word order* errors occurred when segments of the MT output were syntactically incorrect and a *missing word* error when the MT output was missing a word in light of the source text.

In the process of identifying the MT errors, another rater with English native language proficiency—who had been an instructor of English for 11 years at the time of the study—was recruited for identifying the MT error types. One of the researchers of the study and the second rater together coded the errors until a complete agreement could be reached on the identification of MT error types.

TABLE 1
Sum of Machine Translation Errors and Mean Frequency of Machine Translation Errors per 100 words

Error Types		<i>Sum</i>	<i>Min</i>	<i>Max</i>	<i>M</i>	<i>SD</i>
Mistranslations	Word Errors	280	.00	4.72	.679	.879
	Phrase Errors	71	.00	3.09	.177	.392
	Sentence Errors	60	.00	1.39	.146	.238
	TOTAL	411	.00	6.09	1.002	1.049
Ungrammaticality	Wrong Tense	54	.00	1.34	.130	.264
	Singular/Plural Agreement	27	.00	1.57	.072	.215
	Wrong Part of Speech	3	.00	.28	.008	.043
	TOTAL	84	.00	1.57	.210	.333
Word Order		29	.00	.72	.070	.158
Missing Word		16	.00	.89	.040	.141

Stage two consisted of developing the MT EC items. Based on the configuration of MT errors found in stage one, a comprehensive selection of mistranslation errors was selected for item development. For *ungrammaticality* errors, only verb tense was specifically chosen, considering its higher relative mean frequency in the category. Considering the cognitive and linguistic level of the students, a total of 10 MT error items were presented, of which the learners had to correct two MT errors for each type: (1) a mistranslated word, (2) a mistranslated phrase, (3) a mistranslated sentence, (4) wrong word order, and (5) wrong verb tense (see Appendix B for the items). For each item, learners were asked to focus on the underlined MT errors. Considering the linguistic level of the learners and to obtain a controlled set of responses for the specific types of MT errors, erroneous parts of sentences were underlined, as illustrated in Figure 1.

Another key component of the MT EC test consisted of asking learners to mark MT EC strategies employed by them to correct the errors. A range of such strategies were provided for the learners to mark. The choice of strategies was conceptualized prior to developing the MT correction test by conducting an interview on MT correction strategies with students similar to those in the present study. In the MT correction test, the learners were provided with choices of using *background knowledge* (“I have learned or heard of it before”), *guessing from context*, *literal translation*, and “others” for learners to report additional strategies.

FIGURE 1

Sample Item for Machine Translation Error Correction Test and Correction Strategies

<p>한글 해석과 기계번역기 결과물을 비교하면서 밑줄친 오류를 올바르게 수정하세요. [Correct the underlined errors while comparing the results of the Korean interpretation and the machine translation.]</p>	
Item No. 5	
The Source Text	
<p>Beth: 오늘 학교에서 작은 사고가 있었어요. <u>Boyd의 발이 자전거 거치대에 끼었어요.</u> [Beth: There was a small accident at school today. Boyd's foot got stuck in the bike rack.] 엄마: 아 저런! 그래서 발을 어떻게 뺐니? [Mom: Oh my! So how did he take out his foot?]</p>	
Machine-Translated Text (by Google Translate)	
<p>Beth: There was a small accident at school today. Boyd's foot <u>is</u> stuck in the bike stand. Mom: Oh my! So how did he get his foot off?</p>	
<p>수정하는 과정에서 사용한 방법은 무엇인가요? (택 1) [How did you try to correct the error? (Choose ONE)]</p>	
<p>① 이전에 배웠거나 들어본 적이 있음 [I have learned or heard of it before]</p>	<p>② 앞뒤 문맥 또는 내용으로부터 추측 [I guessed from context.]</p>
<p>③ 한글 해석 그대로의 의미 해석 [I literally translated from Korean.]</p>	<p>④ 기타 [Others] ()</p>

Note: [] indicate translations of text in learners' L1

3.3.2. English Proficiency Test

To test the English proficiency of the middle school learners, TOSEL (Test of Skills in the English Language)—a customized English proficiency test considering the level of school curriculum and cognitive level by age—was utilized. For assessment, 30 items corresponding to the Junior level of the Reading & Writing section from the TOSEL Practical Book Junior (International TOSEL Committee, 2017) were selected (Total = 30 points). The learners were tested on Sentence Completion (5 items), Situational Writing (5 items), Practical Reading and Retelling (10 items), and General Reading and Retelling (10 items). The results of the learners' English proficiency was categorized into three groups using visual binning (i.e., to create categorical variables from continuous scale variables) in the Statistical Package for the Social Sciences (SPSS). As three of the students were absent for the test, 94 students' results were analyzed, producing 23 high proficiency ($M = 28.26$, $SD = .449$), 32 mid proficiency ($M = 26.16$, $SD = .808$), and 39 low proficiency learners ($M = 19.72$, $SD = 4.628$). Repeated measure one-way analysis of variance (ANOVA), post-hoc tests, and histograms were used to classify the learners into proficiency groups. The results

of inferential statistics validated them as three independent groups ($F = 69.532, p < .001$).

3.3.3. Procedure

Before the learners were asked to correct MT errors, they had a training session using MT. The training session consisted of an introduction to MT as a recent AI tool; the learners spent time solving sample MT error items to simulate a post-editing process conducted on MT output. During the rest of the training session, they responded to the MT EC test for 50 minutes. For the MT EC task, the learners were not allowed to access any source of reference, such as the dictionary. In another session during the week, the learners were tested on their English proficiency for 50 minutes. The total score for the items of the MT EC test was 10 points.

3.3.4. Data Analysis

The results of the MT EC test, and choice of correction strategies were calculated for descriptive and inferential statistics with SPSS. Regarding RQ1, a two-way mixed repeated measures ANOVA was performed to analyze the effect of error type and English proficiency on the scores of the MT EC test. The independent variables were English proficiency (low, mid, high) and MT errors (five types), and the dependent variable was scores from the MT EC test. For RQ2, mean frequencies of MT EC strategies were analyzed with repeated measures one-way ANOVA to observe any differences in the use of strategies. Further analysis with one-way ANOVA was conducted to check if there were any differences in strategy use between proficiency groups. RQ3 was examined by conducting multiple regression with MT EC scores as the dependent variable and the MT EC strategies as the independent variables. This was further examined to observe if English proficiency led to different results.

4. RESULTS

4.1. L2 Learners' Ability to Correct Machine Translation Errors

The ability of EFL middle school learners to correct errors in the MT output resulted in a mean score of 6.04 ($SD = 2.09, min = 0, max = 9.5$), indicating that the learners had correctly answered around 60% of the total items. None of the errors were corrected perfectly by the learners.

When a two-way mixed ANOVA with repeated measures was performed to analyze the

effect of error type and English proficiency on the scores of the MT EC test, the results revealed a statistically significant interaction effect between error types and English proficiency ($F = 2.633, p = .011$). This indicated that the learners were reacting differently to the types of MC errors according to their levels of English proficiency. The results warranted analysis of simple effects by analyzing errors types and English proficiency separately.

When repeated measures one-way ANOVA was conducted to analyze if there were differences in mean scores by error type, a significant difference was found ($F = 26.466, p = .000$). Post-hoc tests indicated significant differences between MT error types in the learners' ability to correct MT errors, as presented in Table 2.

TABLE 2
Learners' Correction Ability by Machine Translation Error Type

Error Type	Subcategory	<i>M</i>	<i>SD</i>	<i>Post-Hoc</i>	
Mistranslations	Word (W)	.63	.25	W < P*	P = WO
	Phrase (P)	.71	.26	W > S*	P > VT***
	Sentence (S)	.53	.35	W < WO*	S < WO***
Ungrammaticality	Verb Tense (VT)	.44	.31	P > S***	S = VT
Word Order (WO)		.72	.28	W > VT***	WO > VT***
TOTAL		6.04	2.09		

*** $p < .001$, * $p < .05$, $N = 97$

Most noticeably, the learners indicated the lowest ability to correct verb tense errors ($M = 0.44$), which was significantly lower than their ability to correct mistranslation errors (word, phrase) and word order errors ($p < .001$). The results indicate that the learners required a higher level of linguistic knowledge to correct verb tense errors, in comparison to that needed for correcting mistranslation and word order errors. Out of the 97 learners, only 13.4% ($n = 13$) responded correctly to total verb tense items.

The learners' ability to correct verb tense errors ($M = 0.44$) was not significantly different from their ability to correct mistranslated sentence errors ($M = 0.53$); the ability to correct the latter was also lower than that for word order errors ($p < .001$). In comparison to mistranslated word errors, mistranslated sentence errors were also more problematic to correct ($p < .05$).

The results of the test also indicated that the learners' ability to correct mistranslated word errors was lower than those for phrase errors ($p < .05$). This may have occurred when the learners had to notice that the MT error was due to a polysemous word in the source text:

The Korean word “말” [mal] may mean “horse” or “words,” but the MT was unable to make this distinction. The MT produced “Now you have control of the most powerful weapon, the horse*. A soft horse* is stronger than a sharp sword.” Only 12.5% ($n = 12$) of the learners were able to correct this with “word.” In sum, the results on L2 learners’ ability to correct MT errors indicated that verb tense/mistranslated sentence errors are the most difficult types of errors to correct for EFL middle school learners. This was followed by mistranslated word errors, and mistranslated phrase/word order errors.

For a more detailed interpretation of the analysis, the learners’ L2 proficiency was considered. There were significant differences in the learners’ ability to correct MT errors between the high ($M = 7.50$, $SD = 1.08$), mid ($M = 6.19$, $SD = 1.86$), and low ($M = 4.92$, $SD = 2.13$) proficiency groups ($F = 14.601$, $p < .001$). Analysis by error type indicated that there were significant differences between the three proficiency groups in their abilities to correct MT errors ($p < .05$), except for verb tense errors (see Table 3). Post-hoc tests indicated that the learners’ ability to correct MT errors was particularly different between the low and high proficiency group learners for all categories of mistranslation and word order errors ($p < .05$). For mistranslated sentences and word order, there were also significant differences between the low and mid proficiency group learners ($p < .05$).

Taken together, the results indicate that verb tense errors are constant causes of difficulty, regardless of L2 proficiency. In comparison, the significant differences occurring more saliently among groups (low vs. mid, low vs. high) for mistranslated sentences and word order errors may indicate that such errors are relatively more difficult to correct and thus more easily influenced by level of learners’ L2 proficiency.

4.2. Correction Strategies for Machine Translation Errors

Another aspect of the learners’ competence in dealing with MT errors was researched through L2 learners’ employment of EC strategies. Learners were asked to report on the type of strategy employed after correcting an MT error. As there were 10 questions on the test, the maximum number of strategies that could be used for each item was set at 10. Repeated measures one-way ANOVA and post-hoc tests indicated that there are no significant differences in mean frequencies between guessing from context (GC) ($M = 3.36$) and literal translation (LT) ($M = 3.12$) (see Table 4). This indicated that the two were the most used strategies in comparison to other EC strategies. However, mean frequencies of GC and LT were respectively different from background knowledge (BK) ($M = 2.13$) ($p < .05$), demonstrating that learners’ existing knowledge (e.g., pre-existing knowledge of grammar or vocabulary) was less accessed than GC or LT.

TABLE 3
Learners' L2 Proficiency and Error Correction Abilities

		Prof	<i>M</i>	<i>SD</i>	<i>F</i>	<i>Post-Hoc</i>
Mistranslations	Word Correction	Low	.54	.29	5.786**	Low = Mid
		Mid	.64	.21		Low < High**
		High	.75	.17		Mid=High
	Phrase Correction	Low	.62	.32	4.607*	Low=Mid
		Mid	.76	.21		Low<High*
		High	.79	.14		Mid=High
	Sentence Correction	Low	.35	.34	12.296***	Low<Mid*
		Mid	.56	.32		Low<High***
		High	.75	.25		Mid=High
Ungrammaticality	Verb Tense Correction	Low	.41	.30	2.518	Low=Mid
		Mid	.38	.34		Low=High
		High	.55	.26		Mid=High
		Low	.57	.30		12.953***
Word Order Correction	Mid	.76	.23		Low<High***	
	High	.90	.18		Mid=High	

*** $p < .001$, ** $p < .01$, * $p < .05$; Low: $n = 39$, Mid: $n = 32$, High: $n = 23$

TABLE 4
L2 Learners' Machine Translation Error Correction Strategies

	<i>Min</i>	<i>Max</i>	<i>M</i>	<i>SD</i>	<i>F</i>	<i>Post-Hoc</i>
Background Knowledge (BK)	0	9	2.13	2.13	26.487***	BK < GC* OT < GC***
Guessing from Context (GC)	0	10	3.36	2.60		BK < LT* OT < LT***
Literal Translation (LT)	0	9	3.12	2.42		OT < BK***
Others (OT)	0	10	.52	1.47		GC = LT

*** $p < .001$, * $p < .05$, $N = 97$

For the use of others (OT), there were 50 instances reported. When the learners had been offered 970 chances to use EC strategies, OT took up 5.15% of the responses. The learners who had chosen OT, rather than reporting on extra EC strategies used, commented that their

lack of vocabulary knowledge had hindered them from correcting MT errors. Some other learners reported that they had simply guessed the corrections in the MT EC task.

When the learners' employment of EC strategies was further considered by proficiency groups (Low, Mid, High), one-way ANOVA indicated that there were differences in the frequency of having employed MT EC strategies only for BK ($F = 3.675, p < .05$); the high proficiency learners ($M = 3.09, SD = 2.63$) had employed significantly more BK strategies than the mid proficiency learners ($M = 1.63, SD = 1.54$) to rectify the MT errors ($p < .05$). The learners' L2 proficiency did not influence the use of other strategies (i.e., GC, LT, or OT).

4.3. Correction Strategies for Successful Use of Machine Translation

After examining the L2 learners' employment of EC strategies, we analyzed whether the use of EC strategies contributed to learners' ability to rectify the MT errors. A significant regression model was produced ($F = 10.048, p < .001, R^2 = .304$), wherein each EC strategy, except for OT, contributed to the correction of MT errors (BK: $Beta = .595, p < .001$; GC: $Beta = .503, p < .001$; LT: $Beta = .438, p < .01$; OT: $Beta = -.022, p = .839$).

TABLE 5
Predictors of L2 Learners' Machine Translation Error Correction Ability

		Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	Sig.
		<i>B</i>	<i>Std. Error</i>	<i>Beta</i>		
Low	(Constant)	1.369	1.413		.969	.340
	BK	.054	.020	.526	2.713	.010*
	LT	.036	.018	.418	1.943	.060
	GC	.045	.017	.619	2.725	.010*
	Others	.008	.021	.082	.395	.696
Mid	(Constant)	4.201	1.162		3.615	.001
	BK	.042	.022	.352	1.956	.061
	LT	.036	.014	.441	2.480	.020*
	GC	.002	.017	.023	.121	.904
	Others	-.025	.037	-.109	-.667	.510
High	(Constant)	3.302	8.367		.395	.698
	BK	.050	.084	1.210	.590	.563
	LT	.034	.084	.765	.403	.691
	GC	.045	.086	1.147	.519	.610
	Others	.014	.087	.091	.163	.872

Note: * $p < .05$; Low: $n = 39$, Mid: $n = 32$, High: $n = 23$

A detailed analysis by proficiency groups resulted in significant regression models for low ($F = 3.747, p < .05, R^2 = .306$) and mid proficiency learners ($F = 2.934, p < .05, R^2 = .303$), but not for high proficiency learners ($F = .720, p = .590, R^2 = .138$), as presented in Table 5.

5. DISCUSSION

5.1. L2 Learners' Ability to Correct Machine Translation Errors

The corrections made for the errors in the MT output indicated that the learners were successful in correcting around 60% of the errors. The results indicated that mistranslated sentence and verb tense errors are the most problematic for the learners. To correct mistranslated sentences, the learners needed to understand the context in which the target sentence was embedded by going beyond the unit of the immediate sentence that was erroneous. For instance, as Korean is a pro-drop language where subjects can be dropped, the learners needed to check whether the MT had translated the missing pronoun by random assignment. When the learners had to correct "Look at this man. Don't you think you need help?" (Target: Don't you think he needs help?), they had to do so while referring to the preceding sentence. However, the learners' responses occurred in 18 different forms (e.g., him needs, you have need, you feel, need to/your, looks like, and you look at need), wherein only 19.6% ($n = 19$) of the learners had been able to provide the correct form of the referent. This suggested that the learners lacked awareness of the cause of the MT error and a logical solution for correcting the error could not be retrieved easily. This also revealed that the students were unable to use the MT to write when corrections required the knowledge of cross-linguistic differences and awareness of the types of errors that can be made by the MT (White & Heidrich, 2013).

Similarly, correcting verb tense errors was also problematic (Wallwork, 2016). For instance, the grammar correction item required the learners to correct tense when they were presented with "In the early 1480s, Da Vinci began working for Ludovico Sforza in Milan. He has been assigned many roles, such as a musician, a painter, and an engineer"; here the target was "He was assigned many roles." The learners retrieved various forms of the verb (e.g., has/had/has given and has gotten), but seemingly, the learners were unaware of the need to use the simple past tense for a passive construction. For this grammar item, only 20.6% ($n = 20$) of the learners were able to make the correction. The results demonstrate that the verb tense correction item was demanding for the Korean middle school learners. Moreover, the non-significant difference between L2 proficiency groups for the ability to correct verb tense errors (see Table 3) indicates that allowing learners to simply detect the ungrammaticality error (i.e., verb tense) may not be sufficient; instruction to deal with MT errors through direct corrective feedback may be needed for grammatical accuracy (Van Beuningen, De Jong, & Kuiken, 2012).

The mistranslated word and phrase errors caused less of a problem in comparison to mistranslated sentences or verb tense errors. However, mistranslated words seemed more difficult to correct than mistranslated phrases ($p < .05$). The pattern of learners' responses

(e.g., talk/talking, say/saying, speak/speaking, speech, language, and tongue) indicates that they had to retrieve a contextually appropriate lexical item that would collocate with “soft” when stating that “A soft word is stronger than a sharp sword.” This illustrates that to solve a mistranslated word error, learners may need to utilize linguistic knowledge beyond detecting the error of a single word item. The results also demonstrate that the correction of MT errors may call for the productive knowledge of collocations (Granger & Paquot, 2008) (e.g., soft words) that can help L2 learners make more informed choices for accompanying words (e.g., collocates) and phrases (e.g., prefabricated expressions). Conversely, mistranslated phrases may have been easier to correct than mistranslated words as the learners were situated to process the erroneous item as a fixed expression (Wray, 2000), rather than as individual lexical items. When learners were presented with “In the 19th century, shampoo came to have the present meaning of hair winding” accompanied by the L1 translation, “hair” would have primed them to retrieve “hair washing,” which is a familiar expression for the learners. This is in fact a case where the word “hair” can immediately activate generalized event knowledge (McRae & Matsuki, 2009), expediting retrievals of collocations.

The significant differences in MT EC ability among the low, mid, and high proficiency learner groups indicate that L2 language competence can explain the ability to correct MT errors (Chung, 2020; Kliffer, 2005); that is, learners needed to identify the cause of errors for producing a correction when MT errors were underlined in advance for them. In comparison, verb tense errors seemed constantly demanding to solve for the learners, regardless of L2 proficiency.

Taken together, the results of the MT correction task demonstrate that the causes of MT errors may be due to the nature of polysemic words (Abraham, 2009); others can occur when the MT fails to translate cultural references, proverbs/idioms (Correa, 2014), and pragmatic expressions (Ducar & Schocket, 2018). The results indicate that, although MT may have the potential to provide students with viable translations (Jia, Carl, & Wang, 2019), only those who have attained the threshold level of proficiency required to detect MT errors will be able to correct them for application in their L2 writing (Chon et al., 2021; Chung, 2020; Lee, 2020; Tsai, 2019).

Most of all, the range of faulty corrections provided by the learners, when prompted to produce self-retrieved corrections indicated that the competence for using MT subsumes the ability to revise raw MT output by identifying the errors in them and choosing appropriate MT correction strategies, which has been referred to as “post-editing strategies” in the translation studies literature (Konttinen, Salmi, & Koponen, 2020; Pym, 2013; Rico Pérez & Torrejón, 2012). Although the learners in the study were limited to correcting MT errors at the sentential level, general users of MT, when editing with it, would frequently need to use writing strategies such as double-checking, using previous knowledge, inferencing,

paraphrasing, and rewriting (Lee, 2020; Niño, 2008). For instance, double-checking may be used to check if the MT output concurs with the intended meaning. When MT output does not produce word-for-word translations, inferencing strategies may be employed to identify the meaning of MT output. When users are not satisfied with word choices made in the MT output, users may paraphrase or rewrite to better approximate their intended messages. Taken together, our study highlights that while MT can be a viable tool to aid L2 writing, its effectiveness is manifest only when the users notice what is linguistically inappropriate in the MT output (e.g., linguistic competence), and deploy appropriate correction or revising strategies (i.e., strategic competence).

5.2. Machine Translation Correction Strategies and Successfulness of Correction

To correct MT errors, the learners frequently deployed GC to understand the context and utilize clues in them to make the most viable correction. It was mostly used ($n = 51, 52.6\%$) for mistranslated sentence errors. In this case, learners would have to go beyond the sentential level to decode and analyze preceding and succeeding sentences to arrive at the target form.

To the same extent as GC, the learners used LT to correct the MT errors, which was an apparent choice of EC strategy, as L1 was the most immediately accessible source of reference for EC. LT was used most frequently ($n = 47, 48.5\%$) for mistranslated phrase errors. For instance, when the learners were prompted to correct “This challenge was especially difficult for Eun Chong to Dad, because he had to push or pull Eun Chong during the race” (Target: Eun Chong’s Dad), the learners utilized LT to understand the intent of the sentence.

Regarding the impact of L2 proficiency, an overall analysis of the EC strategies indicated that only BK use was influenced by L2 proficiency, and the high proficiency learners used significantly more BK strategies than the mid proficiency learners. However, multiple regression indicated that the frequency of having used specific EC strategies did not consistently contribute to the high proficiency learners’ successful correction of MT errors; a plausible interpretation for the high proficiency learners is that their knowledge of L2 needed for correcting the MT errors may have been sufficient for EC. In comparison, the less skilled L2 learners (of mid and low proficiency) may have needed to employ EC strategies to compensate for their lack of linguistic knowledge (Fung & Macaro, 2021) for correcting MT errors; the low proficiency learners resorted to using multiple strategies (i.e., BK and GC), whereas the mid proficiency learners only deployed LT. While there were no significant differences between the low and mid proficiency groups in their mean frequencies of having employed EC strategies, the low proficiency learners’ employment of

BK and GC and the mid proficiency learners' employment of LT seem to have aided them to correct MT errors.

6. LIMITATIONS AND SUGGESTIONS FOR RESEARCH

The present study was focused on a small set of pre-designed EC tasks for MT errors for developing the MT EC test based on the cognitive and linguistic levels of EFL middle school learners. As such, future studies should be designed to include a broader range of MT errors for diverse learner groups to prompt using a larger breadth and depth of EC processes and strategies. In the current study, the learners were prompted to select EC strategies after having been informed about the location of the MT error. Further studies should seek to include an assessment of L2 learners' ability to notice MT errors; studies should observe how learners may initiate a correction of MT errors, wherein patterns of EC strategies may differ depending on learners' individual difference variables, purpose of writing, and L2 proficiency. In the current study, the learners use of correction strategies was researched through learners' report on them. Using methods such as think-aloud, we may be able to derive a more refined taxonomy of MT correction strategies that are used to correct different types of MT errors. Thus, this calls for more qualitative studies allowing researchers to explore the process of detecting MT errors and employing post-editing strategies. The researchers believe that the present study has started to work in this direction.

7. CONCLUSION

As research on EFL adolescent learners' ability to use MT has been neglected, EFL middle school learners' ability to correct MT errors was examined based on an MT correction task. On the other hand, the notion of using MT in L2 classrooms for academic tasks may be disdained for going against academic honesty (Groves & Mundt, 2015). There is skepticism regarding whether machine-translated work can be considered the original work of a student (Correa, 2011). However, this trend is difficult to disclaim with MT's improved accuracy and accessibility. Another valid argument stems from how current EFL middle school learners are increasingly being exposed to education, wherein the use of technology is being integrated into their curriculum. Similarly, MT can be expected to be the referencing technology of the next generation (Kirchhoff, Turner, Axelrod, & Saavedra, 2011; Van Rensburg, Snyman, & Lotz, 2012). Compared to EFL adult learners, L2 middle school learners would also need more guidance on correcting MT output which may produce inaccurate translations due to culture-specific idioms, field-specific and polysemous terms.

The present study provides pedagogical implications for using MT in L2 writing. First, correcting MT errors will sharpen the L2 learners' linguistic awareness about what may be the more appropriate lexico-grammatical items to be used in L2. Second, trying to edit and revise the raw MT output will encourage learners to develop L2 writing as they try to clearly express their intentions. As part of training for post-editing skills, writing strategies such as paraphrasing, omitting/adding words, and using synonyms will need to be included (Lee & Lee, 2021; White & Heidrich, 2013). For EFL middle school learners who lack the experience of independent L2 writing, MT output can be used as a scaffold to construct sentences in L2. This can become a novel way of teaching L2 writing, provided that valid teacher feedback is available for noticing MT errors and correcting them while writing. To complement the process of MT EC, dictionary search and corpus search skills need to be taught, as the tools can be used to provide a boost in the learners' confidence levels toward MT for independent L2 writing.

Applicable levels: Secondary, tertiary

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APPENDIX A
Errors of Machine-Translated Output

Category	Sub-categories	Explanation	Examples
Mistranslations	Word error	A word does not express the intended meaning	MT: The knight described him as the inventor of dynamite and other dangerous objects used in war. TT: The article described him as the inventor of dynamite and other dangerous objects for war.
	Phrase error	Phrases or idioms do not express the intended meaning	MT: When a product is sold on fire , some people often feel that they will not be able to get it unless they are quick enough. TT: When a product sells like hot cakes , some people often feel that they won't be able to get it if they are not fast enough.
	Sentence error	Sentences or clauses do not convey the intended meaning	MT: If I live in tulou in Fujian, China, a huge, round house , I will always have friends to hang out with at home. TT: If I live in a tulou, a huge round house in Fujian, China , I will always have friends to hang out with at home.
Ungrammaticality	Verb Tense error	Errors with tenses	MT: He wrote a new post with a longer description of his bike. He has attached more pictures to show his bike from a different angle. TT: He wrote a new post with a longer description of the bike. He added more photos to show his bike from different angles.
	Singular/Plural Agreement	Subjects and verbs do not agree with one another in number	MT: Where have everyone been? I found the best way to get out. TT: Where has everyone been? I found the best way to get out.
	Wrong Part of Speech	The part of speech of a word is incorrect	MT: Some looked up at Corky angry , while others yelled at him. TT: Some looked up at Corky angrily , while others yelled at him.
Word Order		Words and phrases are misplaced with an obscure meaning	MT: They need bee help . TT: They need the help of bees .
Missing Word		Word(s) that should have been	MT: It was Christmas Eve () 1914, the first year of World War I.

conveyed according to the source text does not exist in the MT text	TT: It was Christmas Eve in 1914, the first year of World War I.
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APPENDIX B

Machine Translation Error Correction Items

1. “Now you have control of the most powerful weapon, the ‘**horse**.’ A soft **horse** is stronger than a sharp sword,” said the Master. (Target correction: *word*)
2. This challenge was especially difficult for **Eun Chong to Dad**, because he had to push or pull Eun Chong during the race. (Target correction: *Eun Chong's Dad*)
3. Simon: I didn’t have enough money to buy a coat. Sorry. And I don’t know anything about this guy, but it’s not my fault. I had to bring this man home. Look at this man. Don’t you think **you need** help? (Target correction: *he needs*)
4. Spork: **Ms. Where is Disher?** She is gone. (Target correction: *Where is Ms. Disher?*)
5. There was a small accident at school today. Boyd’s foot **is** stuck in the bike stand. (Target correction: *was*)
6. **Using** onions is not fun because it makes you cry. (Target correction: *Chopping*)
7. The meaning of the word shampoo has changed several times since the word first came into English around 1762. In the 19th century, shampoo came to have the present meaning of ‘**hair winding**.’ Shortly thereafter, the word also began to be used to refer to the special soap used for hair. (Target correction: *hair washing*)
8. **I have** a project to share a book. First of all, register your book online and get an ID number. Then, put it in a public place. (Target correction: *There is*)
9. Let’s study the pictures below. **A The person in the picture** is holding an umbrella in the light rain. (Target correction: *The person in picture A*)
10. In the early 1480s, Da Vinci began working for Ludovico Sforza in Milan. He **has been** assigned many roles, such as a musician, a painter, and an engineer. (Target correction: *was*)