An investigation of the potential of machine translation and post-editing to advance students' learning of Chinese and English languages in higher education

by

Li-Ching Chang

張立青

Bachelor of Arts (Foreign Languages and Literature)
Graduate Diploma of Education (Secondary)
Master of Education

A thesis submitted for the degree of

Doctor of Philosophy

UniSA Education Futures



University of
South Australia

April 2024

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Glossary and abbreviations

AI	**Artificial Intelligence** In this study, AI is recognised as a rapidly growing field of study in computer science that replicates human intelligence and has close associations with human language technology (HLT).
CALL	**Computer-assisted language learning** The term refers to the use of technology for language learning and teaching purposes and has become a sub-field in the study of language education.
CEFR	**Common European Framework of Reference for Languages** This is an international standard for describing language proficiency, consisting of six levels: A1, A2, B1, B2, C1 and C2. Learners at A1 and A2 are at beginner and pre-intermediate levels (basic user); at B1 and B2 they are at intermediate and upper-intermediate levels (independent user); at C1 and C2 they are at advanced and proficiency levels (proficient user).
CMI	**Chinese Medium Instruction** This term refers to teaching and learning academic disciplines through Chinese as medium of instruction for students whose L1 is different from Chinese. Although CMI is not the main focus in this study, the findings of this research have implications for language pedagogy in CMI contexts.
EMI	**English Medium Instruction** This term means teaching and learning academic disciplines through English as medium of instruction for students whose L1 is different from English. Although this term was originally used in contexts where English has limited dispersal or use, it is now recognised as applicable to bilingual or multilingual learners studying in predominantly English-speaking contexts.
HE	**Higher education** Post secondary school education.
HEIs	**Higher education institutions** Higher education institutions (HEIs) include universities, as well as technical and professional colleges. In this study they refer to universities.
HLT	**Human Language Technology** Human language technology (HLT) is a subfield of Artificial Intelligence (AI), serving to enable machines to process and understand human

languages. Web-based resources, such as online translators, online dictionaries and search engines, and machine translation are applications of HLT.

HT **Human translation**
This term is generally used in translation studies to refer to translation that is produced manually by human translators, potentially in consultation with dictionaries.

L1 **First language**
A first language (L1) is often known as the home language, local language, or mother tongue. In this study, the L1 refers to the primary language practices and the strongest repertoire of each participant.

L2 **Second language**
A second language (L2) is a language different from the first (or home) language. It is often used as a proxy term that includes 'additional' and/or 'foreign' languages. L2 is used in this study in relation to the learning of additional, second and/or foreign languages.

MT **Machine translation**
Machine translation refers to computerised systems that automatically generate translations. Online translators that provide digital machine translation functions can automatically produce translated texts from one language to another.

PE **Post-editing**
This term is generally used in translation studies to refer to a process or task that requires human translators to edit or modify machine translated text to increase accuracy and/or appropriateness.

SLA **Second language acquisition**
The term second language acquisition (SLA) refers to an interdisciplinary field of study that includes various theories of how additional, foreign or second languages (L2) are learned.

Transcription Conventions

Quotations from participants' written and spoken texts are presented verbatim to retain each individual's voice. All names used for participants are pseudonyms.

…	Elision For example, removal of minimal responses or unrelated material from quotations
[ ]	Alterations For example, clarification made within a quotation and/or insertion of participant's name

Tense Use in Reporting

In Chapters 5, 6 & 7 I use the present tense when showing student translation processes as they unfold inside the tables. I also use present tense when discussing students' habitual or ongoing practices as disclosed in open-ended questionnaire and focus group interview data. I use past tense when discussing student reporting of a one-off task, and when I offer an interpretation of the screenshot data immediately before or after each of the tables and figures that relate to screenshot data.

Referencing

The referencing style used for in-text references and reference lists in this thesis is APA 7th Edition.

Abstract

In the era of artificial intelligence (AI) and digital technology, online machine translation (MT) is becoming a common tool for multilingual learners in academic contexts. As a language teacher in higher education, I have found it important to understand how students use MT and its effects on their learning, because how they use MT has implications for language acquisition and academic integrity. Expertise in MT and post-editing (PE) of MT produced texts is considered important for translation students and multilingual researchers. However, little research has focused on whether MT and PE capabilities are equally important for multilingual learners such as language students and students studying through their second language (L2), for example, through English medium instruction (EMI). Hence, the aim of this study is to investigate the potential of MT and PE to advance L2 learning in the contexts of language learning and teaching and EMI.

To this end, I adopted a qualitative action research methodology involving reflection-in-action (reflection during teaching interventions), reflection-on-action (reflection after the completion of interventions), and reflexivity. The study comprised two different teaching intervention trials for two cohorts of students. The two interventions involved human translation (HT), MT and PE. The first intervention was conducted in a pilot English-Chinese translation course with mostly English-speaking advanced learners of Chinese at National Taiwan University. The students' primary aim was to advance their study of the Chinese language. The second intervention was a pilot MT and PE collaborative tutoring process with Chinese-speaking postgraduate students studying through EMI at the University of South Australia. The primary aim of these students was to learn content knowledge across the curriculum of their chosen discipline and simultaneously to develop their English. I expected that the findings from the two distinct student groups would help me to gain a multi-perspective understanding of participants' L2 learning in relation to MT and PE.

Multiple instruments were used to collect and triangulate data: questionnaires, screen recordings, translation samples, and focus group interviews. The findings from the two groups reveal multilingual learners' purposeful use of MT to support both input comprehension and output production. The students used MT as a multilingual dictionary and as more than a dictionary to assist them in reading comprehension, writing production, evaluating MT output, and maintaining academic integrity. They used MT followed by PE as strategies to support

meaning making and meaning transfer from one language into another. The combined findings also show that learning to use MT and PE through teaching interventions might not only advance L2 learning but also benefit access to content knowledge by increasing efficiency in reading, improving accuracy in text comprehension and production, increasing opportunities for learning and understanding vocabulary and grammar, increasing confidence in learning, and raising awareness of appropriate use of MT. Analysis of the findings indicates that MT and PE allow multilingual learners to draw on their whole linguistic repertoire and semiotic resources to leverage learning of language and knowledge, and that MT and PE enhance multilingual learning and capability through purposeful human-machine interaction. The study offers implications for language pedagogy in both language learning and teaching and EMI contexts.

COVID-19 impact statement

The research interventions included in this PhD coincided with the COVID-19 pandemic in 2020. This has had both direct and indirect consequences for the study. The following details the challenges and changes made in relation to restrictions that accompanied COVID-19.

Owing to the sudden outbreak of COVID-19 in early 2020, international border closures and travel restrictions resulted in many international students either returning to their home countries or being unable to travel for overseas study. Most of the student participants who had registered to participate in the translation course at National Taiwan University, in which I had planned an intervention, withdrew for this reason. Similarly, many Chinese-speaking international students were unable to travel to Australia and enrol at the University of South Australia. These circumstances significantly reduced the number of student participants in this study. COVID-19 restrictions also made my original planned on-site teaching interventions and data collection impossible.

In response to the unexpected disruption of the pandemic, I made swift changes to my initial research design and teaching interventions from face-to-face delivery to online teaching modes via Zoom for both cohorts of students. Despite the sudden changes in the research design, online teaching interventions with two small groups of students enabled me to collect screen recorded data for in-depth observation and analysis, and to work closely with the research participants on the Zoom platform.

Declaration

I declare that:

this thesis presents work carried out by myself and does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; to the best of my knowledge it does not contain any materials previously published or written by another person except where due reference is made in the text; and all substantive contributions by others to the work presented, including jointly authored publications, are clearly acknowledged.

Li-Ching Chang

……  ….. 15 April 2024

Acknowledgements

In the past few years of my PhD journey, I have received so much encouragement and assistance from many people. Your inspiration, care, spiritual or physical companionship have given me strength to make this journey possible and accomplished. I would first like to thank all the student participants who took part in this study. Without your participation and experience sharing, this research would not have been possible. Many thanks to my colleagues at National Taiwan University for your assistance in recruiting student participants in Taiwan.

Next, I would like to express sincere gratitude to my supervisors for your support and guidance over the process of my study. I am very grateful to Professor Kathleen Heugh for your endless patience, rational and emotional company along the way, just like a mother. Your profound knowledge and insightful viewpoints have inspired me to think deeply about the meaning of language education. A big thank you to Dr Enza Tudini for sharing the theoretical knowledge of second language acquisition and of language learning with technology, which has been of great help to my research. Thank you to Professor Ning Gu for your perceptive and structural comments on different parts of the thesis. My appreciation also goes to Dr Mei French for joining the supervisory team in the last year of my PhD. I have benefited so much from your valuable feedback and your expertise in data chapters' organisation and formatting. A thank you to Dr Xuan Li for helping with assessing student participants' translations for this study. I also want to express my gratitude to Dr Jenny Barnett for your insightful suggestions and generous care in editing this thesis.

I would like to acknowledge the Commonwealth Government's contribution through an Australian Government Research Training Program Scholarship, without which this research would not have been possible.

Many thanks to Research Support Staff at UniSA Education Futures for your assistance along the way. Special thanks to Dushie Lalic for providing support during my difficult times. Similarly, I am grateful to IT staff and librarians for their help during my study. I also appreciate my PhD peers for your encouragement and company. Because of you, I don't feel lonely. Because of you, I know I can complete this difficult journey.

Finally, I would like to express my gratitude to my family in Taiwan, especially 爸爸 (dad) and 媽媽 (mum) for your care and warm wishes. Many thanks to Caesar for your spiritual and

financial support over the past few years. I am also grateful to Serena for your patience and independence so that I can focus more on my study. Last, I want to express my deep gratitude to my 乾爸 (ganba) and 乾媽 (ganma) in Adelaide. I appreciate the hot meals you make every day, which means a lot to me and makes me feel at home.

I dedicate this work to 爸爸 (1941-2023) who always asked me to take good care of myself and taught me that having good health is more important than anything else. Although you were unable to see my completion of this PhD, you would be very proud of your daughter accomplishing her goal.

Thesis related publications and presentations

Publications

Chang, L. C. (2022). Chinese Language Learners Evaluating Machine Translation Accuracy. *JALT CALL Journal*, *18*(1), 110-136. https://doi.org/https://doi.org/10.29140/jaltcall.v18n1.592

Heugh, K., French, M., Arya, V., Pham, M., Tudini, V., Billinghurst, N., Tippett, N., Chang, L. C., Nichols, J., & Viljoen, J.-M. (2022). Multilingualism, translanguaging and transknowledging: Translation technology in EMI higher education. *AILA Review*, *35*(1), 89-127. https://doi.org/https://doi.org/10.1075/aila.22011.heu

Windle, J., Heugh, K., French, M., Armitage, J., & Chang, L. C. (2023). Reciprocal multilingual awareness for linguistic citizenship. *Language Awareness*, 1-18. https://doi.org/https://doi.org/10.1080/09658416.2023.2282585

Presentations

Chang, L. C. (2020), 'Beyond error corrections – the multiple roles of machine translation in facilitating university students learning Chinese as an L2', paper presented at UniSA Education Futures Higher Degree by Research (EDC HDR) Forum, Adelaide, South Australia, 12 November 2020.

Chang, L. C. (2021), 'Teaching students how to make appropriate use of machine translation – findings from an intervention in an English-Chinese translation course', paper presented at the 2nd Online International Doctoral Research Conference in Education via Zoom, 7 July 2021.

Chang, L. C. (2021), 'Bi-/multilingual students' use of machine translation to facilitate English academic writing in the postgraduate study through English', paper presented at UniSA EDC HDR Forum, Adelaide, South Australia, 11 November 2021.

Chang, L. C. (2022), 'Bilingual students using post-editing of machine translation to overcome the challenges of paraphrasing in source-based academic writing', paper presented at Australian Association for Research in Education (AARE) Conference, Adelaide, South Australia, 30 November 2022.

Chang, L. C. (2022), 'Post-editing of machine translated text: an aid to academic writing for bi-/multilingual postgraduate students', paper presented at Australian Council of TESOL Associations (ACTA) International Conference, Brisbane, Queensland, 27 September 2022.

Heugh, K. & Chang, L. C. (2022), 'Bi-/multilingual students' use of human and machine translation in Higher Education: translanguaging, transknowledging and academic integrity', paper presented at Adelaide University Academic Integrity Colloquium, Adelaide, South Australia, 29 September 2022.

Chang, L. C. (2023), 'Machine translation and post-editing supporting bilingual students' paraphrasing and summarising process in academic writing', paper presented at International Symposium on Bilingualism (ISB), Sydney, NSW, 29 June 2023.

Chang, L. C. (2023), 'Translation technology facilitating translanguaging practices in academic learning', paper presented at UniSA EDC HDR Forum, Adelaide, South Australia, 9 November 2023.

1 Introduction

I am passionate about teaching languages, including Chinese and English. I have taught both languages in Taiwan and Australia. Specifically, I taught Chinese as a second language for more than 15 years in higher education in Taiwan. Prior to studying this PhD in 2019, I was lecturing in the International Chinese Language Program (ICLP) of National Taiwan University. In addition to teaching general Chinese language courses, I offered two English-Chinese translation courses, one for advanced level learners of Chinese and the other for Australian and New Zealand diplomats who were studying Chinese at ICLP and were required to undertake an English-Chinese translation-based examination[1] prior to their posting in Taiwan or Mainland China. My own experience in language teaching and second language acquisition (SLA) and teaching translation in SLA classrooms made me curious about the role of translation in language learning and teaching. I conducted small-scale research studies between 2014 and 2018 and found that translation as a pedagogical tool could benefit students in language learning, for example, in strengthening previously learned vocabulary and grammar. With advances in digital technology, I have been concerned about the role of human language technology (HLT) in language education, particularly online machine translation (MT), one of the applications of HLT. I was curious about whether MT, such as Google Translate, was involved in students' translation processes. Given the increasing interest in artificial intelligence (AI), it seemed that there would be room to investigate the affordances and limitations of MT technology in the process of translation and language learning.

[1] The assessment task is prepared by the Language Studies Unit in the Department of Foreign Affairs and Trade (DFAT) in Canberra. The assessment includes reading in English and speaking in Chinese, listening in Chinese and writing in English, Chinese-English interpreting, translating from Chinese to English.

1.1 Contextualisation of the study

As a language teacher with 20 years of language teaching, I started with the concept of second language[2] (L2) learning with a focus on theories of second language acquisition (SLA). As this PhD study progressed, I have come to understand how multilingual people employ their whole linguistic repertoire to make meaning and to make sense of their multilingual and multicultural worlds. Multilingual learners naturally use their prior language(s) and knowledge to learn and strengthen their developing language and knowledge. Increasing recognition of multilingualism as a norm of daily life has led to a shift in thinking within the field of SLA. Fifteen prominent SLA scholars in the Douglas Fir Group (2016) conclude that SLA theory needs to be reconceptualised through the lens of societal multilingualism. Amongst these scholars, Ortega (2013, 2019) argues that SLA should include multilingualism as an object of study.

Multilingualism comes with social trends such as globalisation, internationalisation and the attraction of overseas study, bringing people from different languages and cultures into frequent contact. In terms of studying abroad, an increasing number of international students study the Chinese language in higher education institutions in Taiwan or Mainland China. An article titled 'Chinese progresses as a world language' in the *Language Magazine* (2021) shows that approximately 25 million people are currently learning Chinese as an L2. Many universities in China have begun to offer or are likely in the future to offer degree programs through Chinese Medium Instruction (CMI) for international students, thereby promoting Chinese as an academic lingua franca (see for example, Song, 2022; Wan & Gao, 2020).

There has been considerable interest in and provision of English Medium Instruction (EMI) in many countries, although its definition and application has undergone change. Originally it was considered to mean 'use of the English language to teach academic subjects (other than English itself) in countries or jurisdictions in which the majority of the population's first language is not English' (Macaro, 2022, p. 534). Although the term EMI has typically been used in non-Anglophone contexts, several scholars, including Humphreys (2017), problematise this narrow definition and suggest that it applies also in Anglophone settings such as in Australia where multilingual learners with first languages different from English study. Of relevance to this

[2] Based on the definition of Ellis (2015), I use L2 as an umbrella term, referring to learning any language other than learners' first language (L1).

study, Ferguson and Spinks (2021) report that the majority of international students currently travelling to Australia for higher education (HE) study come from China. As a result of increasing numbers of international students studying overseas, either to learn an L2 or to pursue a higher degree through their L2, I include two different cohorts of multilingual learners in my study. The first group comprises mainly English-speaking learners of Chinese in predominantly Chinese-speaking Taiwan. The second group comprises Chinese-speaking students studying postgraduate degrees through EMI in predominantly English-speaking Australia.

Whereas language learners aim to advance the study of the target language (the L2) to expand their multilingual capabilities (Gao & Yang, 2023; Ortega, 2019), students studying through EMI aim to learn content knowledge across the curriculum of their chosen discipline and concurrently to learn or expand their L2 capabilities in English (Fenton-Smith et al., 2017; Lin, 2019; Tsou & Baker, 2021). A common purpose among these students is to use their varied linguistic repertoires to advance their L2 expertise towards high-level bilingualism or multilingualism.

My purposes here have been to understand how multilingual learners in two different academic contexts use translation to mediate the transfer of meaning between languages, to facilitate understanding of information in different languages, and to acquire knowledge of different languages. When translation is used for pedagogical purposes to improve language capability, language teaching cannot be separated from translation studies (Carreres, 2014; Colina, 2002). Learning a language may be related to learning to translate from or into that language to achieve multilingualism (Cook, 2010). Owing to the differences in historical and theoretical backgrounds, the terms ‘translation’ and ‘translanguaging’ have distinct theoretical underpinnings and applications in language education. Despite this, both translation and translanguaging are used as pedagogical methods and tools to support language learning and to strengthen language capability. The common purpose of both is to draw on learners varied linguistic repertoires to leverage learning, as will be discussed in detail in the thesis.

Human Language Technology (HLT) has played a significant role in the rapidly developing field of Artificial Intelligence (AI) and is likely to continue to do so. An important function of HLT is to offer people from different language communities access to information and to share knowledge through the use of web-based resources (Varile et al., 1997). Web-based resources such as online translators, online dictionaries, corpora, and search engines are applications of

HLT and can be used in language education (Bodomo & Lam, 2006). Online sources of translation, also known as online machine translation (MT), have greatly improved in translation quality since the advent of state-of-the-art neural machine translation (NMT) systems (Briggs, 2018; Niño, 2020). Baidu, the largest search engine in China, has employed NMT systems for MT services in the language pair of Chinese and English since 2015 (He, 2015). Baidu's use of NMT was followed by Google Translate from 2016 (Wu et al., 2016) and Microsoft Translator from 2018 (Hassan et al., 2018). Youdao translator tool, developed in China and known for Youdao Dictionary, has also adopted NMT systems (Fu et al., 2018). These and other innovations in MT technology are attracting increasing attention in language education and translation studies.

With the features of accessibility and user friendliness, MT has become one of the most popular tools for many language learners (Jolley & Maimone, 2022; Lee, 2023; Tsai, 2020) and for multilingual students studying through EMI (Heugh et al., 2022). However, academic staff in 'anglophone' settings such as Australia are often concerned about students' use of MT and the influence of this on students' L2 development; they also worry that MT use leads to breaches of academic integrity. Some teaching staff, however, consider that these possibilities depend on how MT is used (Ducar & Schocket, 2018; Groves & Mundt, 2021). Despite the debates on MT use, language and EMI students are very likely to continue using MT 'clandestinely' if it is prohibited and openly if 'sanctioned' (Mundt & Groves, 2016, p. 388).

Given that MT quality has greatly improved since the launch of NMT systems, some studies suggest that the quality of translation produced by MT may outperform language learners (Lee, 2022b; Tsai, 2019). A few scholars, taking advantage of the positive aspects of MT, integrate it into L2 writing classes (Chen et al., 2019; Chen & Tsou, 2023; Lee, 2020; Tsai, 2020). These scholars teach university students of English to use MT output[3] in English to compare with their own L2 English writing for editing and revising. However, MT output is still not error-free despite the improvement in MT quality. Some research shows that advanced level learners can benefit more from MT than intermediate or beginner level learners because their language capability enables them to judge the degree of accuacy in MT output (Lee, 2022a, 2022c; Lee & Briggs, 2021; Niño, 2020).

[3] The term 'output' is used in the broadest sense in this thesis, referring to translations produced by MT (i.e., MT output) and production of L2 writing produced by students.

Recently, capability in post-editing (PE) of MT produced text has become highly sought after in the translation industry because competent PE can increase translation productivity while maintaining quality (Cadwell et al., 2018; Shih, 2020b). Developing skills in MT and PE, hence, have been considered to be important for students in translation programs (Pym & Torres-Simón, 2021; Varela-Salinas, 2019). Some scholars have also urged that understanding how to use MT and PE is essential for multilingual researchers in scholarly communication and publication (Bowker, 2020; Bowker & Ciro, 2019; O'Brien et al., 2018). Owing to the high demand for PE tasks in translation industries, some language teachers introduce MT and PE to students at upper-intermediate or advanced L2 language learning levels in the translation class (Kliffer, 2005; Niño, 2008; Yamada, 2019). They require students to undertake PE of raw MT output to render more accurate and appropriate translation output. The implication is that PE may play a significant role in translation, including encouraging students to evaluate MT accuarcy and to correct MT output.

Nevertheless, the development of expertise in the use of MT and PE has received relatively little explicit pedagogical attention in mainstream L2 teaching and EMI contexts. This is despite many language and EMI students having made use of both MT and PE in their studies. For this reason, it seems worthwhile examining MT and PE in both language learning and EMI settings and in light of SLA debates that turn towards multilingualism.

The core aim of this study, therefore, is to investigate the potential of MT and PE to advance L2 learning in the contexts of language learning and teaching and EMI. More specifically, I am interested in how multilingual learners use MT to mediate the equivalence of meaning between languages to support their L2 learning. I also wish to understand whether MT and PE can advance L2 learning in both contexts. Therefore, the research questions are:

1. *How do multilingual learners use MT to support their L2 learning?*

2. *Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?*

1.2 Research design and significance

Following the suggestion by the scholars in the Douglas Fir Group (2016) on positioning SLA through the lens of multilingualism, in this study I use multilingualism as an umbrella term that includes bilingualism and refers to the use of two or more languages (see also Cenoz, 2013; Cummins, 2021). I use the term ‘multilingual learners’ to embrace ‘bilingual learners’ and to refer to students who draw on two or more languages (their multilingual repertoire) in learning

and studying. A qualitative action research study was designed to include two different teaching intervention trials using MT with multilingual student cohorts. These cohorts are identified below in relation to their strongest L1 and the target language of their study program. The first trial involved a translation course for (mostly) English-speaking advanced learners of Chinese in a predominantly Chinese language context at National Taiwan University. The second was with a group of postgraduate Chinese-speaking students studying through EMI in a predominantly English language context at the University of South Australia. Each intervention involved translation activities, including human translation, machine translation and post-editing of machine produced texts. In this study, human translation (**HT**) means a translation method, in which translation is produced manually by students, potentially in consultation with (electronic or paper) dictionaries. Machine translation (**MT**) refers to free online MT tools with the latest neural machine translation systems that users can access via the web, including Baidu, Google Translate, Microsoft Translator, and Youdao[4]. Post-editing (**PE**) refers to a translation method, in which translation is first generated from MT followed by student post-editing to achieve an appropriate translation (i.e., **MT+PE**). The term 'post-editing of machine translation, PEMT' was originally used at the beginning of my study. However, I changed it to 'MT+PE' at a later stage as it shows the clear sequence of translation that is produced from MT followed by human post-editing. In this study, the two terms PE and MT+PE are used interchangeably. I tend to use MT+PE when I want to emphasise the sequence of the translation process. Figure 1.1 shows the definitions of HT, MT and PE in this study.

[4] These MT tools differ from generative AI tools such as ChatGPT launched in late 2022. Generative AI tools were not developed at the time of data collection for this study. As the name suggests, MT tools can only undertake translation tasks, while ChatGPT can do both translation and text generation tasks.

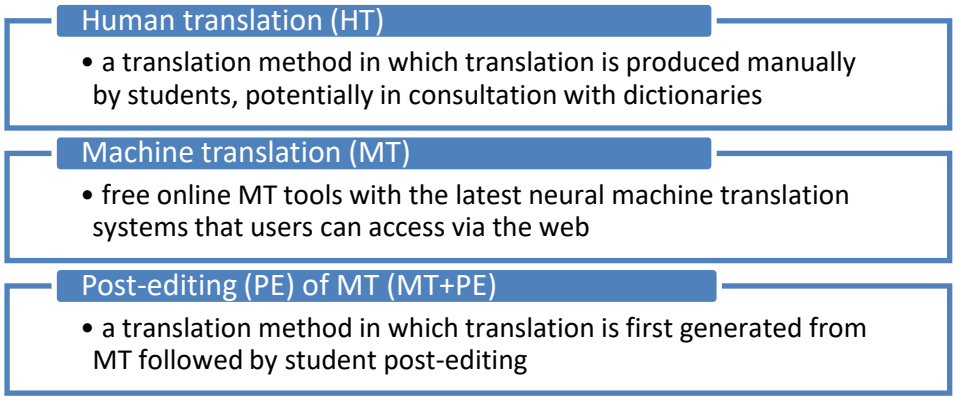


Figure 1.1 Definitions of HT, MT and PE in this study

Given that the activity of MT+PE is more suitable for students at advanced levels of language learning (Niño, 2008, 2009), the L2 proficiency requirements of the research participants for both student groups in this study were B2/C1 (upper-intermediate/advanced) levels based on the Common European Framework of Reference for Languages (CEFR). The first intervention focused on Chinese language learning by engaging in HT, MT and PE activities in a pilot English-Chinese translation course for advanced learners of Chinese. The second intervention focused on a pilot collaborative tutoring process involving the use of HT, MT and PE to support EMI postgraduate study. The two student groups in my action research enabled me to gain an understanding of the potential of MT and PE to advance L2 learning in two different contexts, one focusing on Chinese language learning in a language program, the other focusing on the learning of content knowledge and English through EMI.

Just as the intervention for Student Group 1 (SG1) at the National Taiwan University was about to begin in early 2020, the unexpected disruptions of COVID-19 occurred. Since many international students were unable to travel, this reduced the number of student participants in the translation course from 15 to four. It was no longer possible to conduct an on-site teaching intervention, so I amended the original research design to online teaching via Zoom. The pandemic also limited to six the number of Chinese-speaking postgraduate students in Student Group 2 (SG2), because COVID travel restrictions prevented many international students from travelling to and enrolling at the University of South Australia. A face-to-face teaching intervention design was also changed to a Zoom platform in compliance with this university's COVID-19 regulations. Limitations relating to the sample size of both groups are discussed at various points in the thesis. Nevertheless, this disruption did allow for in-depth analysis of the data that indicates potential value in further research.

Through this action research, I have sought to reveal the ways in which multilingual learners with CEFR B2/C1 levels use MT technology in the two contexts of language learning (SG1) and postgraduate study through EMI (SG2). In so doing, I have built on the work of scholars in the field of MT in language education and educational technology, such as Niño (e.g., 2020) and Lee (e.g., 2020). From the start, I aimed to contribute an understanding of how multilingual learners interact with and use MT to support L2 learning, and as a result of this research, I offer multilingual learners' five 'purposeful uses'[5] of MT in assisting input comprehension (L2 reading) and output production (L2 writing). I further aimed to contribute an understanding of whether MT and PE capabilities can advance L2 learning in both a language (as object of study) and an EMI context. Through observation and analysis of interactions between students and machines (human-machine interaction), I provide some insights into the nature of MT and PE capabilities. I also identify five interrelated processes that advance student language learning and access to content knowledge when learning to use MT and PE.

I argue that findings in the study shed light on the implications of MT and PE for language learning and teaching and EMI. They also provide language educators and academic teaching staff in higher education with some insight into the complexity of metacognitive and metalinguistic processes in student use of MT and PE. This may contribute towards informed institutional policy-making decisions regarding the use of MT, including in relation to matters of academic integrity. I hope that the findings of this research will be beneficial in the fields of SLA, translation studies, multilingual education, EMI studies, and language education more generally associated with MT technology. Recommendations that emerge from this study include the pedagogical use of MT and PE when applying translation to language teaching and EMI (and potentially also to CMI) contexts.

1.3 Structure of the thesis

Following this introductory chapter, there are two literature review chapters. The focus in Chapter 2 is on a review of literature relating to theory and research on language learning and applied linguistics, while the focus in Chapter 3 is on human language technology (HLT) and machine translation (MT). In Chapter 2, I begin with a review of SLA theories including incidental/implicit and intentional/explicit learning, interactionist SLA theory, and the role of L1 and multilingualism in SLA. I then discuss the resurfacing of translation in language

[5] The term 'purposeful use' is adopted from Dr Mei French's 2018 PhD thesis.

learning and teaching through two distinct lenses, namely translation and translanguaging. In Chapter 3, attention is drawn to recent developments in MT and its applications in language education. This includes teachers' and students' perceptions of MT, and the applications of MT in the language classroom. I also explore the role of MT and post-editing (PE) for purposes of professional translation, and academic research and publication.

Chapter 4 presents the study's methodology, namely, action research and how I adapted two frameworks, those of Burns (2009) and Norton (2018), to develop a five-phase action research framework for the two student groups in this study. Chapters 5 and 6 present data and initial discussion of the findings in relation to both research questions, from SG1 (students of the Chinese language) and SG2 (EMI postgraduate students) respectively. These chapters reveal how students of each group make strategic use of MT and PE for input comprehension and output production, and how students advance their learning of language and knowledge through learning to use MT and PE. In Chapter 7, I bring an in-depth discussion and analysis of how MT and PE can contribute to SLA, translation, translanguaging, and multilingualism in education. Chapter 8 concludes this thesis with a review of key contributions and research significance and recommendations for teaching practice and future research.

2 SLA, translation, and translanguaging

My study is located at the intersection of translation studies with second language acquisition (SLA), second language (L2[6]) learning, and translanguaging pedagogy. The purpose of this chapter is to offer a review of literature that brings together the theory and research in these fields of study in order to engage with language acquisition and translation in language learning and teaching.

I begin with selected theories in the field of SLA that relate to L2 and multilingual learning and that are relevant for this study. In section 2.1, I offer an overview of cognitive language learning theories, including incidental/implicit and intentional/explicit learning, interactionist SLA theory, and the role of the first language (L1) and multilingualism. In Section 2.2, translation, which has been regaining attention in SLA over the last fifteen years, is considered through a pedagogical lens in translation studies and language teaching, and in translanguaging and multilingual education. Translation and translanguaging in language teaching and the use of translation in mediating meaning making in language learning are addressed in this section. The chapter concludes with a chapter summary in Section 2.3.

[6] I use L2 as an umbrella term to refer to learning any language that is different from the L1. I use the terms 'foreign language' and 'additional language' in relation to how particular authors use the terms and as reflected in the literature.

2.1 Second language acquisition (SLA) - selected theories

This section comprises a discussion of theoretical perspectives in SLA, including 1) incidental or implicit learning versus intentional or explicit learning; 2) interactionist SLA theory; and 3) the role of L1 and multilingualism in SLA. These offer multi-perspectival opportunities to understand the processes of L2 learning that lead to a multilingual repertoire.

2.1.1 Incidental/implicit vs intentional/explicit learning

It is widely considered that language learning involves the cognitive process of input and output to construct and reconstruct an internal lexical and grammatical system (e.g., Krashen, 1991; Mackey & Gass, 2015; Swain, 2005). Ellis (2015) explains that language input and output can be meaning-focused or form-focused, primarily depending on learning purposes and goals:

> Input is meaning centred when the learners' primary concern is to comprehend…Output is meaning centred if the goal is simply to communicate some message…Input is form centred when the learners' primary attention is directed at studying and learning the linguistic forms…Output is form centred when the learner is primarily concerned with conforming to target language norms (p. 146).

Incidental learning (i.e., when learners acquire some linguistic forms without focussed attention) may occur when learners pay attention to comprehending input. This differs from intentional learning (i.e., when learners aim to learn linguistic features and forms). Ellis (2015) argues that input and output can involve both incidental learning and intentional learning 'when learners engage primarily in trying to understand, but also pay periodic attention to linguistic form when the need arises' (p. 146). The notions of incidental and intentional learning are related to those of implicit and explicit learning. As Brown (2014) puts it:

> …explicit learning involves conscious awareness and intention…implicit learning is the other side of the coin: learning without conscious attention or awareness (p. 291).

According to Brown, incidental and intentional learning are synonymous with implicit and explicit learning. Implicit learning is incidental without awareness about what has been learned, while explicit learning is intentional with awareness of what has been taught (Ellis, 2015; Gass, 2017; Long, 2017). Implicit learning gives rise to implicit knowledge, and explicit learning leads to explicit knowledge. The former refers to learners not being aware of what language knowledge they use to complete tasks such as comprehension; the latter refers to learners being aware of what language knowledge they use for tasks such as syntactic rules (Gass, 2017; Long, 2017). Ellis (2015), on the other hand, suggests that explicit learning can play an assistive role in the process of implicit learning:

> If learners have explicit knowledge of a grammatical rule, they are more likely to pay attention (i.e. 'notice') exemplars of this rule in the input they are exposed to and - through noticing - fine-tune their developing, implicit knowledge-system…learners could use their explicit knowledge to construct sentences in the L2, which then served as 'auto-input' that fed into the mechanisms responsible for implicit learning (pp. 16-17).

Accordingly, explicit and implicit learning are interrelated and complementary. A hybrid of both learning types within a focus-on-form approach (Long, 2014, 2017) that involves both implicit and explicit learning and knowledge has been considered to be most beneficial. In his review paper, Ellis (2016) concludes that a focus-on-form approach is in contrast with a focus-on-forms approach. The latter is a structure-based approach, focusing on grammatical structure. The former has come to be viewed as specific types of activities or procedures designed to attract learners' attention to form while their primary attention is on the meaning of a given task. From cognitive-interactionist perspectives, communicative interaction involves implicit and explicit learning and focuses on meaning and form to varying degrees (Ellis, 2015; Gass, 2017; Gass & Mackey, 2014). This is the main focus in Section 2.1.2.

2.1.2 Interactionist SLA theory

From cognitive-interactionist perspectives, the constructs of interaction in SLA include input hypothesis (Krashen, 1985), interaction hypothesis (Long, 1983, 1996), output hypothesis (Swain, 1985, 1995), and noticing hypothesis (Schmidt, 2001). Interaction hypothesis was proposed by Long (1983) and updated in 1996 (Long, 1996). Long's updated version of the interaction hypothesis pays particular attention to negotiation for meaning and views negotiation during interaction as a key to L2 acquisition:

> Negotiation for meaning, and especially negotiation work that triggers interactional adjustments by the NS [native speaker] or more competent interlocutor, facilitates acquisition because it connects input, internal learner capacities, particularly selective attention, and output in productive ways (Long, 1996, p. 451-452).

Long argues that negotiation brings together input, attention, and output and contributes to language acquisition. With a substantial growth in empirical research, the interaction hypothesis has developed into a theoretical approach, which is called the interaction approach (Gass & Mackey, 2014). Whether it is the interaction hypothesis or the interaction approach, interactionist scholars aim to explore L2 learning mechanisms through real-time spoken interaction, from learners' exposure to input, negotiation for meaning and form, to production of output, together with learners' attention to the feedback received from the interlocutor during negotiation. Chapelle (2003) uses the term 'interactionist SLA theory' to refer to the essential

constructs of interaction; she then connects interactionist SLA theory to computer-assisted language learning (CALL), defined as 'the use of technology for language teaching and learning' (Chapelle, 2005, p. 743). Chapelle (2005) aims to explore language learning through learner-computer interaction in both synchronous and asynchronous communication. Regardless of synchronicity or asynchronicity, such types of communication include video interaction (Dooly & Tudini, 2016) and text messaging such as online written chat (Tudini, 2003, 2007) . Building on this, and for consistency, I use the term 'interactionist SLA theory' to denote the key constructs of interaction, which include input, interaction and feedback, output, and attention.

2.1.2.1 Input

Learners' exposure to L2 input is an essential component for language acquisition. Krashen's (1985, p. 2) input hypothesis asserts that 'if input is understood and there is enough of it, the necessary grammar is automatically provided.' He argues that comprehensible input benefits learners more in language acquisition, whereas input containing 'i+1' is also important for acquisition. Krashen (1991, p. 409) refers to 'i' as learners' current language level and i+1 as the next level that learners have not yet acquired but are 'ready to acquire'. This is similar to Vygotsky's (1978) notion of Zone of Proximal Development (ZPD). Liu (2015), however, criticised Krashen's account for the i+1 formulation as vague, owing to the lack of explicit definition. In terms of comprehensible input, previous research shows that language teachers use modified input to make language more comprehensible, namely adapting input to learners' language levels (Gass & Mackey, 2014). Language input is of little use to learners in constructing their L2 grammar or syntax if they cannot comprehend the input to which they are exposed.

Gass (2017, p. 4), on the other hand, proposes 'comprehended input', which differs from Krashen's comprehensible input in terms of comprehensibility control and comprehension types. Whereas comprehensible input emphasises that control resides with input providers (speakers/teachers) rather than receivers (hearers/learners), comprehended input focuses on learners and the extent to which they can understand the input provided. In terms of comprehension types, Krashen views comprehension as a dichotomy: that is, input is either understood or not understood. In contrast, Gass (2017) regards comprehension as a continuous ability of learners, from understanding the meaning of the input (semantic level) to being able to analyse the syntax of the input (syntactic level).

2.1.2.2 Interaction and feedback

Whereas Long's interaction hypothesis (1983, 1996) refers to interaction as real-time face-to-face conversation that learners take part in to negotiate meaning (Gass & Mackey, 2014; Loewen & Sato, 2018), Ellis (1999) argues that interaction can include intrapersonal thinking activities. Scholars such as Ortega (1997, 2017) and Chapelle (2003, 2009) expand the concept of interaction to learner-computer interaction to consider L2 acquisition in the CALL context. As Chapelle (2003) argues, 'interaction needs to include what takes place between a person and the computer' (p. 55). Computer technology serves as 'new interlocutors and ways of interacting' in language learning (Palfreyman & Benson, 2019, p. 671). Thus, the notion of interaction has evolved over time and now embraces interpersonal, intrapersonal, and learner-computer interaction.

Gass and Mackey (2014) advocate that interaction is important as it permits learners to receive information about the degree of correctness of their utterances/output. It is assumed that L2 learners may notice inaccuracies through negotiation for meaning and negotiation of form during spoken interaction (Loewen & Sato, 2018). Ellis (2000, p. 199) explains that the process of negotiation for meaning draws learners' attention to 'linguistic form in the context of a primary focus-on-meaning and in so doing induces the 'noticing''. In addition, negotiation of form, where more attention is paid to linguistic accuracy, may occur when corrective feedback is provided, usually by teachers, on learners' inaccuracies in language use, even when the meaning is comprehensible (Loewen & Sato, 2018). Regardless of whether negotiation relates to meaning or to form, Gass and Mackey (2014) argue that feedback received from this process plays an important role in attracting learners' attention to their appropriate and inappropriate use of the L2 target language:

> Feedback may help to make problematic aspects of learners' interlanguage salient and may give them additional opportunities to focus on their production or comprehension, thus promoting L2 development (p. 187)

The term 'interlanguage' was identified by Selinker as a separate language system 'when adult second language learners spontaneously express meaning using a language they are in the process of learning' (1972, cited in Tarone, 2018, p. 2). This means that corrective feedback obtained during negotiation or interaction may assist with self-correction of the output/interlanguage, which is considered to be crucial for L2 acquisition (Gass, 2017). The feedback received, whether explicit or implicit, may subsequently bring learners' attention to the linguistic problems in their internal linguistic system and stimulate them to produce

modified output. L2 acquisition therefore may take place when language learners receive feedback on their output and when learners are motivated to revise their output to make it comprehensible.

2.1.2.3 Output

Output was viewed as an outcome and a *product* of learning in the 1980s; however, over the past few decades it has come to be seen as an action and a *process* of learning (Swain, 2005). Swain (1995, 2005) proposed the output hypothesis in 1985 to complement Krashen's input hypothesis after investigating immersion learning programs for children in Canada. She found that although children in immersion programs received considerable input and developed some competence in the L2, they did not produce enough output or achieve competence in grammar. Therefore, she argues that learners need to be pushed towards output so that they can convert semantic knowledge (comprehension) into syntactic knowledge (production). Swain (1985, p. 249) called this 'comprehensible output' and stated that negotiation needs to include the element of pushing learners towards 'the delivery of a message that is not only conveyed, but that is conveyed precisely, coherently, and appropriately'. In other words, transforming semantic processing to syntactic processing requires pushing learners to make output or pushing them to make modifications in the output. The output, including the modified components, in turn, may develop and/or strengthen syntactic knowledge. As Swain (1995) later asserts:

> …output may stimulate learners to move from the semantic, open-ended nondeterministic, strategic processing prevalent in comprehension to the complete grammatical processing needed for accurate production (p. 128).

In short, the output hypothesis is about the learning process and what learners do when being pushed to produce L2 language (Swain, 2005). As a result of focusing on the process rather than the product, Swain (1995, 2005) has proposed three functions of output as a process. First, output can serve as a 'noticing and triggering' function. That is, through output learners can notice their language gap when they find that what they express does not effectively convey what they want to say, or when they find they cannot express themselves precisely. This function of output relates to Schmidt's (2001) 'noticing the gap', which is discussed below. Second, output can play a 'hypothesis-testing' function. Learners can test their linguistic hypotheses by using particular language forms to attempt to communicate their intention. They may subsequently receive feedback in an interaction to modify their output. A study by McDonough (2001) showed that learners producing modified output incorporating feedback

on syntactic forms seemed to learn more than those who did not do so. Producing output, especially modified output, on the other hand, can help learners to develop the ability to analyse the language (Gass, 2017). This can be referred to as metalinguistic capability, which is the third function of output that Swain (2005) proposes – a 'metalinguistic (reflective) function'. That is, learners use language to reflect on the use of language of others and themselves, i.e., how language is spoken and written. Metalinguistic ability is the capacity to use language as an object of inquiry rather than simply as a tool for communicating ideas (Gass, 2017). Activities such as judging the accuracy of given sentences and translation tasks can develop learners' metalinguistic capability, in which learners are required to reflect on language rather than merely use language.

2.1.2.4 Attention

Schmidt's (2012) noticing hypothesis proposed in 1990 results from an investigation into the acquisition of English by an adult Japanese learner, and his own learning of Portuguese in Brazil. He argues that language learners need to pay attention to and be aware of language features of input in order to acquire or internalise the features of L2 grammar or to form hypotheses about grammatical rules. If learners do not attend to the language input they are exposed to, the language features of that input are unlikely to be stored in learners' internal linguistic system.

In addition to the importance of paying attention to language input, Schmidt (2012, p. 30) also refers to 'noticing the gap' to emphasise that 'learners must make conscious comparisons between their own output and target language input' in order to overcome inaccuracies in the L2. He further argues that learners' motivation and individual differences have an impact on learners' attention and noticing, and therefore affect L2 learning:

> Paying attention results in more noticing, and motivated learners may also try harder and more persistently to understand the significance of noticed language, achieving higher levels of awareness and enhanced learning as a result (2012, pp. 40-41).

In addition to the psychological factors that influence L2 learning such as motivation and individual differences, there are linguistic factors, including the role of L1, varied linguistic repertoires, and linguistic distance between L1 and L2 that also influence L2 learning.

2.1.3 The role of L1 and multilingualism in SLA

SLA research has undergone three main changes in research direction related to the use of L1, from valuing the role of L1 in L2 acquisition, to minimising the use of L1, and subsequently

to exploring its influence on L2 acquisition (Gass, 1988), these changes being related to shifts in language teaching methods and approaches (further discussed in Section 2.2). Nevertheless, in general, L1 has been considered to be an important factor in language learning and acquisition (Brown, 2014; Ellis, 2015). This is clarified by Ellis (2015):

> Currently, there is no theory of L2 learning that does not acknowledge the importance of the first language… They [current theories] emphasize the need to view the first language as one of many factors that shape L2 development and seek to explain how the learner's first language knowledge interacts with other external and internal factors (p. 118).

When learning a language, the stronger the L1 system is established, the greater the influence on the language (L2) that is being learned (Guion et al., 2000). The influence of L1 on the output in the L2 relates to language transfer, which Ellis (2015, p. 118) explains as 'the linguistic features of one language [that] influence those of another language'. The more similar or cognate the language pairs (e.g., English and Spanish), the more help the L1 can provide in learning the L2. In contrast, distant or non-cognate language pairs (e.g., English and Chinese) may require more time in acquisition.

As discussed thus far, SLA researchers often view L2 learners' interlanguage as a separate system (Tarone, 2018), which is neither like the L1 nor the target L2, and which may be positively or negatively influenced by the learners' previous knowledge of L1 and L2. Language learning, in this sense, is based on monolingual native speaker norms and the idea that L2 learners aim to become native-like speakers of the language they are learning (Cenoz & Gorter, 2019). Recently, Ortega (2013, 2019) has critiqued the monolingual bias and native speaker bias in SLA and argued that the object of study in SLA should include learning more than one language, bilingualism and multilingualism:

> In forging a disciplinary alliance with the study of bi/multilingual acquisition in all its manifestations, other new positive framings and greater transdisciplinary relevance would ensue for SLA in the future. Harnessing and embracing the study of L2 acquisition as the study of late bi/multilingualism would help SLA research communities to generate knowledge that contributes to overarching research goals in the study of language ontogeny (Ortega, 2013, p. 17).

In his recent review of SLA history, Ellis (2021) posits that the multilingual turn has become a prominent area of recent research and development in SLA. The multilingual turn as suggested by May (2013), draws attention to learners' entire linguistic resources, i.e., multilingualism. Scholars working with multilingualism do not tend to regard this concept as multiple monolingualisms. Instead, they suggest that the multilingual repertoires of language

learners should not be overlooked or viewed as a deficit but should be used as a resource to leverage learning (e.g., Cenoz & Gorter, 2019; Gao & Yang, 2023; May, 2019). Teaching practices that value the L1 of learners or integrate the whole linguistic repertoire of learners into learning, such as translation (e.g., Cook, 2010) and translanguaging (e.g., García & Lin, 2017), have been considered to be effective and achieve equitable learning outcomes. Consequently, what follows is a review of recent developments in language teaching methods and approaches in SLA research that intersect with translation and translanguaging.

2.2 Translation in SLA

The foundation of language teaching as a professional field was developed in the early 20th century as applied linguists and educational stakeholders attempted to establish principles for effective language teaching (Richards & Rodgers, 2014). Many different teaching methods and approaches have been investigated in SLA research.

When discussing the use of translation in language teaching, one may think of the traditional Grammar Translation Method (GTM). However, GTM is only one possible type of pedagogy using translation in language teaching. Objections to the use of GTM are mostly due to its disregard of communicative competence, although facilitating learners' development of explicit knowledge of linguistic forms is still an advantage (Cook, 2018). Before discussing the applications of translation in SLA, we need to consider changes in prevailing language pedagogy over time. Figure 2.1 presents a historical overview of language teaching methods and approaches, which is elaborated in Section 2.2.1.

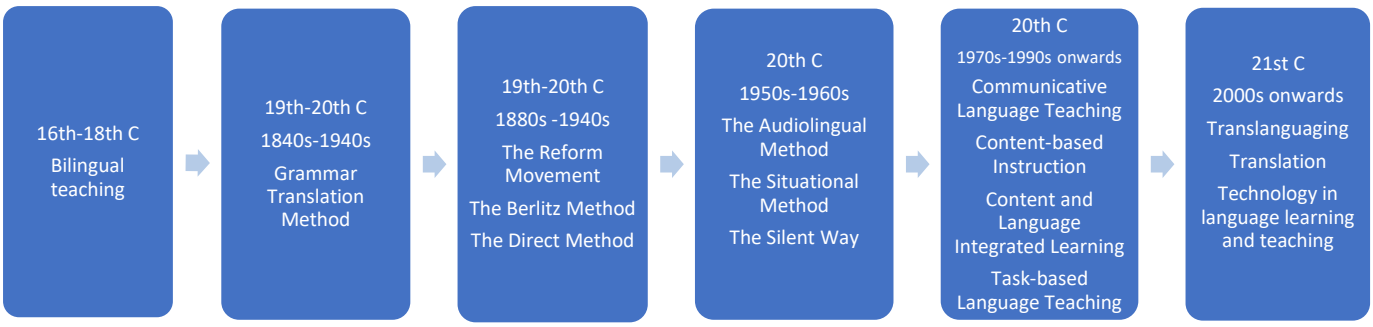


Figure 2.1 Historical changes in language teaching methods and approaches (adapted and compiled from Richards & Rodgers, 2014, and Cook, 2010)

2.2.1 The rehabilitation of translation in language teaching

As shown in Figure 2.1, from the 16th to 18th centuries, bilingual teaching was used in foreign language education in England for the purpose of teaching Latin texts, where the teaching focus was on word for word translation (Pym & Ayvazyan, 2016). At the end of the 18th century, the teaching pedagogy shifted towards a grammatical rules-based focus, and language educators applied the pedagogy of translation as a means to teach grammatical rules and enable learners to read classical Latin. By the 18th century, the pedagogy of teaching foreign languages in European schools was based on the principles for teaching Latin (Richards & Rodgers, 2014). Towards the mid-19th century, GTM, first known as the Prussian Method in the US, was derived from the teaching of translating the 'dead' languages including Latin. It emphasised grammar, reading, writing, and accuracy, in which the main purpose of learning languages was to read the literature of the target language. From the 1840s to 1940s, GTM became increasingly prominent in foreign language teaching in European secondary schools (Cook, 2010; Richards & Rodgers, 2014).

However, starting from the 1880s, GTM was questioned and objected to as a result of the Reform Movement. The reformers began to pay attention to the development of spoken language capability, and translation was used only for explaining words and checking comprehension. The language teaching principles that developed led to the emergence of monolingual teaching methods, attempting to make L2 learning like L1 learning; these included the Berlitz Method and the Direct Method in commercial and private language schools (Cook, 2010; Richards & Rodgers, 2014). The Direct Method subsequently became divided into form-focused teaching methods such as the Audiolingual Method in the 1950s and meaning-focused teaching such as Communicative Language Teaching from the 1970s. Meaning-focused methods led largely to the end of bilingual teaching (Cook, 2010). Nevertheless, Hall and Cook (2012) affirm that although monolingual instruction dominates in early SLA research until the late nineties, bilingual teaching methods such as translation continue to be used by language teachers around the world, especially when learners and teachers share the same or related languages.

According to Richards and Rodgers (2014), the language learning theory underpinning form-focused teaching is based on cognitive-code learning, viewing language learning as a cognitive process and a mental activity. In contrast, the language learning theory of meaning-focused teaching is based on interaction theory, seeing language learning as an interactive process. Negotiation of meaning and modification of input to facilitate understanding is essential in

language learning, as indicated in Section 2.1.2. As a result of the social turn, meaning-focused teaching draws on sociocultural learning theory, viewing language learning as a process of interaction 'between people (teachers and students), objects (texts, books, images), and culturally organized activities and events (instructional acts and sequences)' (Richards & Rodgers, 2014, p. 28). The interaction between teachers and students serves to provide scaffolding in the learning process.

Since the early years of the 21st century, there has been a renewed interest in translation in language teaching, resulting from increasing global communication and multilingualism (Cook, 2010), and reflected in the recognition and awareness of linguistic diversity and human mobility (Heugh et al., 2017). The use of mixed languages and translation between or among languages is commonplace due to a great deal of migration, international communication, and exchange of information in different languages online or on social media. Globalisation, bilingualism, multilingualism, and the significance of identity are all accompanied by a turn towards recognising the use of multilingual teaching in multilingual and multicultural societies (Gao & Zheng, 2019; May, 2019; Ortega, 2019; Shen & Gao, 2019).

Using the L1 of learners and judicious use of translation (Cook, 2010; Källkvist, 2013) is resurfacing in the teaching process. Cook (2018, p. 290) claims that translation is one of multiple ways of using 'own language(s)' of learners to help learning. The use of L1 and L2 in language learning contexts may be related to translation (Pintado Gutiérrez, 2021), for example, pedagogical translation (e.g., Leonardi, 2010) and translanguaging (e.g., Heugh, 2018). These result from different historical and theoretical contexts and have distinct purposes in language education. All in all, the use of L1 or translation is recognised as inevitable and 'natural' in the language learning process (Pym & Ayvazyan, 2016). The following is a discussion of pedagogical translation through the lens of translation studies and language teaching and translanguaging through the lens of multilingual education.

2.2.1.1 Translation – through the lens of translation studies and language teaching

For many years translation attracted little attention in language teaching as a result of the rejection of the traditional Grammar Translation Method and the dominance of monolingual teaching derived from various pedagogies including the Direct Method and Communicative Language Teaching in the late 20th century. At the time, there were researchers looking at the relationship between translation studies and language teaching, adopting different perspectives.

Some scholars regarded translation studies and language teaching as two distinct disciplines, while some believed it to be unrealistic to draw a strict boundary between the two (Carreres et al., 2021; Pintado Gutiérrez, 2021). Gradually, a new term 'pedagogical translation' arose in the 1980s, which was used to describe translation-based pedagogy in language teaching. This term distinguishes translation in language teaching from professional translation pedagogy. Leonardi (2010) provides a definition of pedagogical translation:

> If translation is employed for pedagogical purposes then it can be referred to as "pedagogical translation" and it can prove to be a useful aid aimed at teaching and learning foreign languages (p.81).

De Arriba García[7] (1996) proposed three objectives of using pedagogical translation in the language classroom: text translation, mental translation, and explanatory translation. Text translation was used to work on reading comprehension and writing production through translating from L2 to L1 and L1 to L2 respectively. Students could learn grammar through comparing the two languages. As a second objective, mental translation was used to guide students, particularly at the beginning stage of learning the target language, in using translation from L2 to L1 as a strategy to understand the meaning of the text in L2. The third objective, explanatory translation, used translation in class to explain words, sentence structures, and concepts and to check comprehension of learning materials. De Arriba García (1996) stressed that the main purpose of pedagogical translation was not to teach translation but to use translation as a tool for language teaching. Two decades later, Pintado Gutiérrez (2021) put forward the use of pedagogical translation from a different angle. She incorporated the three uses of translation and regarded pedagogical translation as a set of translation skills that could be developed by various types of translation tasks with the purpose of mediating meanings between languages.

Taken together, pedagogical translation can be utilised as a teaching and learning tool to develop both language and translation capabilities by performing a range of translation tasks or activities into or out of the target language (cf. Kerr, 2016; Leonardi, 2010). Pedagogical translation comprises the use of translation and learners' linguistic resources to mediate and transfer meanings from one language into another, through which learners advance language

[7] De Arriba García's (1996) paper was written in Spanish, therefore, to understand this author's ideas of pedagogical translation, I used Google Translate together with Pindado Gutiérrez's (2021) article in which De Arriba García's paper was cited.

learning. In so doing, students have opportunities not only to compare the similarities and differences in semantics, syntax, and pragmatics between or among languages but also to gain interlingual and intercultural awareness (Chang, 2011 ; Källkvist, 2013) and metalinguistic awareness (Colina & Lafford, 2017). This notion is supported by Cummins' (2007, p. 233) argument that 'learning efficiencies can be achieved if teachers explicitly draw students' attention to similarities and differences between their languages'. The contrastive analysis of languages and working on translating back and forth between languages are seen as beneficial in language learning.

In addition to using translation as a pedagogical tool, there continues to be a significant body of research that refers to the conventional notion of four language macro-skills (i.e., listening, speaking, reading, and writing). Traditional views of the four skills as separate are often challenged through the emergence of multimodal texts in which the four skills are seen as integral capabilities rather than ones that language learners need to develop separately (Gao, 2019a). Authors within this body of scholarship believe that these language abilities developed in language learning may overlap with the capabilities developed and enhanced in translation. As such, translation can be considered a fifth skill or capability in language teaching and should be integrated into the language curriculum (Carreres, 2014; Colina, 2002; Colina & Lafford, 2017; Cook, 2018; Leonardi, 2010). This argument is supported in the guidelines of the Common European Framework of Reference for Languages (CEFR), which has classified translation as one of the learning activities in language education since 2001(Alonso-Pérez & Sanchez Requena, 2018).

From the perspective of most scholars and researchers in the field of translation studies, however, translation in language teaching differs from professional translation pedagogy (Carreres, 2014; Colina, 2002; Colina & Lafford, 2017). Researchers in translation studies often see clear dichotomies between language students and translation students, and between language learning and translation learning. Having an adequate command of working languages is often a prerequisite for translation students in translator training programs. However, Kelly (2014) points out a false belief that translation students have already acquired sufficient proficiency in their working languages prior to commencing the translation training program. This indicates that the difference between 'translation as a means' (i.e., pedagogical translation) and 'translation as an end' (i.e., professional translation) has become 'blurred' when it comes to advanced L2 teaching (Carreres, 2014; Colina & Lafford, 2017). Cook believes that 'the two can never be completely isolated from each other' (p. 291). From this

perspective, translation as a means is closely associated with translation as an end, especially for advanced learners who may be required to have some translation capability in their current social lives and in their future career or study.

Carrerers (2014) argues that well-designed pedagogical translation is not only to help language learners and potential translators improve language competence but also to provide them with an opportunity to understand the challenges they may encounter in translator training programs or translation industries. Colina (2002), therefore, suggests that it is necessary to build a closer relationship between the field of language teaching and translation studies. Pedagogical translation, in this sense, is positioned 'at the intersection of language education and translation studies', combining the perspectives of language teaching and translation studies (Pintado Gutiérrez, 2021, p. 223). Colina and Lafford (2017) propose a definition of translation in language teaching:

> Translation as a cross-linguistic mediation process of, or a product resulting from, transferring or mediating text(s) of different lengths (ranging from words and sentences to entire books) from one human language to another, which generally requires a significant degree of resemblance or correspondence (p. 114).

This definition of translation in language teaching appears to be in a way based on and related to translation studies. The degree of correspondence or equivalence between two texts, i.e., the original/source text and the translated/target text, depends on the purpose of translation and requirements for the target text (Colina & Lafford, 2017; Nord, 2005; Williams, 2013). In other words, correspondence or equivalence between the source and target text plays an important role when seeing translation as a product.

Translation as a process, on the other hand, usually entails decoding of the source text, a transfer of meaning from the source language to the target language, and recoding into the target text (Nord, 2005; Williams, 2013). Nida's (1969) three-phase model of the translation process consists of analysis, transfer, and restructuring, which is considered applicable to either translator training or general translation teaching (Kim, 2015). According to Nida, the first phase (analysis) is to analyse the source text including semantics and syntax and to gain a full understanding of the text information. The second phase (transfer) is to make a transfer of meaning corresponding to the target language and culture, with a focus on interlingual and intercultural meaning transfer to achieve equivalence of meaning between texts. The third phase (restructuring) is to translate and restructure the transferred items to generate a linguistically and culturally appropriate target text. In addition, translators may be required to

make both intralingual (within the same language) and interlingual (between languages) text analysis in order to render more adequate translation products (Nord, 2005). Widdowson's (2014, p. 225) 'intralingual textual reformulation', i.e. a summary or paraphrasing of a text, and Jakobson's (2021) 'intralingual translation or rewording' explicitly indicate the importance of the interpretation of a source text in the translation process. Interlingual analysis embracing intercultural text transfer and comprehensive analysis of two texts and languages is also essential (Nord, 2005). Accordingly, translation is not only a complex cognitive and linguistic process but also a complex metacognitive and metalinguistic process. Language learners are encouraged to draw on their knowledge in languages and cultures in the translation process, through which they are expected to expand their language capabilities and develop skills in translation (Colina & Lafford, 2017).

2.2.1.2 Translanguaging – through the lens of multilingual education

Translanguaging is a relatively new term. The term was translated from a Welsh word 'trawsieithu', which was coined in the 1980s by a Welsh educator, Cen Williams, referring to the use of two languages as teaching practices in Welsh-English bilingual classrooms (Lewis et al., 2012). According to Lewis, Jones, and Baker (2012), translanguaging in this sense means deliberately switching 'the language mode of input and output in bilingual classrooms' (p. 643); for example, learners are exposed to input in one language (e.g., English) and produce output in another language (e.g., Welsh). Learners in such bilingual classrooms are expected to develop their bilingual capabilities while learning subjects across the curriculum. Baker (2011), therefore, argues that translanguaging is 'the process of making meaning, shaping experiences, gaining understanding and knowledge through the use of two languages' (p. 288). García and Wei (2014) adopt William's term, translanguaging, but they use the term differently and refer to translanguaging as:

> discursive practices that cannot be easily assigned to one or another traditional definition of a language, but that make up the speakers' complete language repertoire (García & Wei, 2014, p. 22).

They see translanguaging as a practice or an approach in which multilingual speakers' entire linguistic repertoire is viewed as an integrated linguistic system (García & Wei, 2014; Wei & García, 2022). Despite the different use of this term, translanguaging can be seen as involving three dimensions of multilingualism: the vertical, horizontal and complementary dimensions (Heugh, 2015). First, the vertical dimension of multilingualism is in relation to the deliberate use of two separate languages in bilingual education for the purpose of developing high

achievement of bilingualism as Williams (1996) described. According to Heugh, the vertical use of translanguaging focuses on formal written translation and interpreting between parallel separated monolingual systems for high stakes purposes such as legal systems and academia, where high level multilingual proficiency is required.

Second, the horizontal dimension of multilingualism relates to dynamic fluid language practices. These serve the purpose of establishing positive affective conditions in ways that reduce inequalities in classrooms, similar to the notion of translanguaging advocated by García and Wei (2014). The horizontal use of translanguaging focuses on informal and convivial practices of linguistic border-crossing to make meaning. The boundaries between languages are permeable and fuzzy in horizontal translanguaging to create co-operative and bridging language practices. The horizontal approach of using the entire linguistic repertoire in everyday life helps the vertical strategy of academic literacy development in school learning (French & Armitage, 2020). Third, the complementary dimension of multilingualism combines both vertical and horizontal use of translanguaging together with two-way exchange and translation of knowledge systems, namely 'transknowledging'. Heugh (2021) refers to transknowledging as the process and product of reciprocal knowledge exchange, including through informal and formal uses of translanguaging.

Similarly, Cenoz and Gorter (2021) argue that the dimensions of translanguaging include pedagogical translanguaging and spontaneous translanguaging. Cenoz (2017) has made a distinction between these two:

> Pedagogical translanguaging is planned by the teacher inside the classroom and can refer to the use of different languages for input and output or to other planned strategies based on the use of students' resources from the whole linguistic repertoire. Spontaneous translanguaging refers to fluid discursive practices that can take place inside and outside the classroom (p.194).

Cenoz considers that pedagogical translanguaging serves an instructional function including the original concept of translanguaging from Williams, but it also involves other strategies intentionally planned by the classroom teacher to use learners' resources from their entire linguistic repertoire. Spontaneous translanguaging, however, represents the language use of multilingual speakers inside and outside the classroom where boundaries between or among languages are fluid, permeable and shifting constantly (Cenoz & Gorter, 2021). Spontaneous translanguaging resonates closely with García and Wei's (2014) or Wei and García's (2022) perspective on translanguaging, and Heugh's (2021) discussion of horizontal translanguaging.

In the context of Chinese L2 classrooms, however, Wang (2018) describes how translanguaging is used as a pedagogical approach by employing learners' L1 to scaffold and explain L2 knowledge (e.g., vocabulary and grammar) and to provide activity instructions and feedback. Likewise, learners also use translanguaging to clarify and solve language problems with either teachers or peer students. In this sense, translanguaging is treated in particular as an explanatory and bridging tool to check comprehension of learning content and to clarify challenging lexis and syntax. Using translanguaging in this way is similar to the nature of using translation in the Reform Movement in the late-19th century and also has similarity to De Arriba García's (1996) and Pintado Gutiérrez's (2021) pedagogical translation in which translation is used to explain vocabulary and grammar and to ensure understanding of learning materials, as previously discussed. As a result, Tsou (2021) views translanguaging as a scaffolding strategy in a multilingual education context.

In summary, whether it is regarded as including vertical, horizontal, and complementary dimensions, pedagogical and/or spontaneous purposes, or as a scaffolding and/or clarifying tool, the aim behind the use of translanguaging is to activate learners' repertoires of languages. It is also to encourage learners to draw on their full set of linguistic and semiotic resources to mediate their internal linguistic systems in learning processes and language practices (Gao, 2019b; Heugh et al., 2022; Thomas et al., 2022; Tsou & Baker, 2021; Wei & García, 2022).

2.2.1.3 Translation vs Translanguaging

There are distinctions between translation as a process or product and as a language teaching tool or learning outcome, and translanguaging as a pedagogical tool or approach and a process or practice among multilingual speakers. Baynham and Lee (2019) argue that translanguaging is a strategy of simultaneous integration of different linguistic and semiotic resources in one's repertoire rather than a translation activity followed by a translated product:

> Translanguaging can be a way of understanding the routine moment-to-moment flux and bricolage of translating as an activity, where translators draw on their multilingual repertoire and artefacts in the environment, such as the internet, dictionaries, and databases, in coming up with a translation "equivalent" (p. 53).

From the perspective of Baynham and Lee, translation is a series of activities encompassing linguistic and cultural analysis, translanguaging and using one's own repertoire, and a concrete product created from this process. This notion corresponds with the idea of Pintado Gutiérrez (2021), suggesting translation as an encompassing term including pedagogical translation and translanguaging. However, Heugh et al. (2017) regard translanguaging as an umbrella term that

includes cognitive processes and practices involving different kinds of translation, including translating and interpreting. In a related discussion, García et al. (2017) argue that translanguaging pedagogy may involve various cross-lingual processes such as translation. In a nutshell, whether translation includes translanguaging between or across different linguistic and semiotic resources or whether translanguaging entails translation between two or more languages, both translation and translanguaging have been, and are being used as teaching and learning approaches in language education.

2.2.2 Translation and translanguaging in language teaching

Some studies criticise translation in language teaching by questioning its shortcomings, such as teacher-centred learning, focus on writing and accuracy rather than speaking and fluency, emphasis on memorising vocabulary and grammatical rules by rote (Chang, 2018; Cook, 2010), and word-to-word translation providing misleading information (Pym & Ayvazyan, 2016). Apart from these critiques, the assumed disadvantages of translation include reducing exposure to the L2, delaying the process of L2 production, and the inability to apply translation strategies in multilingual classes because of the diversity of L1s in the same class (Artar, 2018). Likewise, some language teachers view translanguaging as a hindrance in language education owing to their limited understanding of this approach and the lack of support from school leadership and policies (Prilutskaya, 2021). Teachers' negative views on translanguaging stem largely from the stardard monolingual curriculum and assessment systems, in which learners' repertoire of languages is not valued and not incoporated into teaching practice (Costley & Leung, 2020). This suggests that the lack of multilingual education curriculum and policy support and implementation has become a barrier to the use of translanguaging pedagogy in language teaching. Nevertheless, Kerr (2016) argues that thus far there is a dearth of literature that validates the effectiveness of monolingual pedagogy (i.e., target language only instruction) in language teaching over the past two decades. Likewise, Baker and Tsou (2021) assert that 'translanguaging practices are always present regardless of whether they are officially sanctioned or recognised' (p. 183).

Despite the above criticism, many studies have shown that using translation as a pedagogical approach can improve L2 reading (Jiménez et al., 2015), enhance L2 writing (Colina & Lafford, 2017; Kim, 2011; Lee, 2018), consolidate previously learned L2 knowledge (Chang, 2014, 2016), and develop intercultural competence (Kramsch, 2014; Tasker, 2016). On the other hand, employing translanguaging as a pedagogical approach can improve linguistic expertise in both L1 and L2 (Heugh et al., 2017; Li et al., 2016), increase knowledge acquisition

and understanding (Lin, 2019; Wang, 2019), and facilitate bidirectional exchange and translation of knowledge, i.e., transknowledging (Heugh et al., 2022).

More specifically, Jiménez et al. (2015) used translation as a teaching approach to improve L2 reading competence of middle school bilingual students. Students in their study showed improvement after an intervention involving reading L2 English text, translating some excerpts into L1 Spanish, and commenting on the translations of their peers. Jiménez and colleagues found that the students could compare and contrast between languages and develop metacognitive and metalinguistic awareness in L1 and L2 through translation and discussion activities. Lee (2018) required Korean university students of English to translate their written draft in L1 Korean to L2 English and observed increases in students' writing confidence and writing capabilities. Heugh et al. (2017) adopted translanguaging pedagogy in several English as additional language courses with undergraduate students with Chinese language backgrounds who were studying through English medium instruction (EMI) at an Australian university. Their findings show that students' writing capability in L1 Chinese is strongly related to their writing capability in L2 English, and that students' capability in translation between L1 and L2 is also correlated with their proficiency in L1 and L2. They argue that using translanguaging as a pedagogical approach can enhance learners' expertise in both L1 and L2.

2.2.3 Translation in processing input and output in language learning

The practice of translation may occur explicitly or implicitly when learners process language input and output, although it may not necessarily be used as a teaching approach. Widdowson (2014, p. 237) describes this translation practice as 'a general pragmatic process of meaning making that is an essential feature of all language use'. As the author suggests:

> We are not all translat**ors**, but we are all translat**er**s in that we are all capable, in varying degrees, of interpreting texts so as to derive our own discourses out of them. This capability comes to the fore when we come across texts that are linguistically unfamiliar in one way or another. L2 language learning … is essentially also a matter of exercising this capability and extending its application to other texts in another language. In this way, the other language is related to the L1 and becomes part of an expanded plurilinguistic repertoire (p. 237, emphasis in original).

According to Widdowson, the ability of meaning interpretation will occur when dealing with 'linguistically unfamiliar' texts, something which applies to all language learners. They are not necessarily translators but 'translaters' who often engage in interpreting and meaning making of materials in the target language they are learning, particularly for challenging texts. The practice of translation or translanguaging involving interpreting and meaning making from or

into texts in L2 is a part of language learning, through which learners' entire linguistic repertoires can be exploited and extended. The studies by Heugh et al. (2017) and Li et al. (2016) further illustrate Widdowson's perspective, showing that translating back and forth between L1 and L2 appears to be a regular process for students studying through EMI to understand academic learning materials and complete assignments in L2 English. In general, students who study through EMI use English to learn subject knowledge across the curriculum, aiming to accomplish learning of both content knowledge and English language (Fenton-Smith et al., 2017; Lin, 2019), although English language teaching is generally not the focus in EMI classes (Tsou, 2021; Tsou & Kao, 2017b).

When students' academic capabilities in their L2 are not as extensive as in their L1, they are very likely to encounter difficulties in academic reading and writing (e.g., Arkoudis & Tran, 2010; Singh, 2019; Tajik et al., 2022). A study by Trenkic and Warmington (2019) in a UK university shows that Chinese international students with CEFR B2/C1 English proficiency (an average IELTS score 6.92) are at an academic disadvantage compared with their English L1 peers, even though their English entry scores meet and even exceed the minimum admission requirement[8]. According to their study, the Chinese students are at a disadvantage in several ways. These include having a smaller vocabulary in English than their English L1 peers, being less able to understand and summarise academic learning materials and requiring twice as long to read academic texts in English. Academic writing tasks including paraphrasing and summarising entail comprehension of source texts and a transfer of relevant information from a variety of reading materials into coherent academic text. This complex metacognitive and metalinguistic process is often difficult for L1 writers or novice L1 writers; however, it is even more challenging for L2 writers (Hirvela & Du, 2013; Shi, 2012). L2 writers in EMI programs are required to undertake the complex processes of academic language input and output in their L2. As such, EMI students often wrestle with paraphrasing or summarising and organising ideas in academic writing as a result of inadequate academic capabilities, even though they have met the English proficiency requirements for admission to university (Singh, 2019; Tajik

[8] According to IELTS in Australia, IELTS score requirements for undergraduate studies in most Australian universities is currently set at an overall score of 6.0; postgraduate studies require an IELTS 6.5 overall score (https://ielts.com.au/australia/prepare/article-42-universities-in-australia-for-ielts-score-of-5-5-and-above). These scores are substantially lower than the 6.92 (average) score in the study by Trenkic and Warmington (2019).

et al., 2022). This indicates that English proficiency tests, such as IELTS, cannot be reliable indicators of students' academic literacy capabilities (Trenkic & Warmington, 2019). Hu and Trenkic (2021) point out that students may receive training on how to perform well in IELTS tests and they may take the exam many times until they meet the minimal proficiency requirement. However, the scores obtained from repeated exam taking cannot truly reflect students' academic literacy skills.

Taken together, the results of prior research suggest that passing English proficiency tests for university entry does not ensure students' success in academic reading and writing, and that high level language proficiency tasks in university entry or screening assessments cannot and do not guarantee a student's capability in academic use of English. The results of previous studies also indicate that the use of learners' repertoires of languages such as through translation or translanguaging represents an alternative to monolingual pedagogy and the language policy that advocates target language only instruction (Gao & Yang, 2023; Tsou & Baker, 2021). Whether or not translation or translanguaging is applied as a pedagogical approach, students using two or more languages in their studies appear to use translation to support input and output processes of meaning making, particularly for texts with which they are linguistically unfamiliar (Heugh et al., 2017; Heugh et al., 2022; Widdowson, 2014). This may justify why Hall and Cook (2012, p. 283) consider translation a 'natural and effective means of language learning' and Widdowson (2014, p. 237) regards translation as a 'pragmatic process of meaning making'.

In the era of digital technology, however, translation is essentially inseparable from translation tools, online-based resources and the internet (Jiménez-Crespo, 2017; Jiménez-Crespo & Ramírez-Polo, 2021). As Olohan (2017, p. 279) argues, 'technology is an integral part of translation practice'. This suggests that technology plays an essential role in the process of mediating meaning making and access to learning content (Chun, 2016; Ortega, 2017), and therefore it may have an impact on language learning and acquisition. The main focus in the next chapter is on human language technology (HLT), particularly machine translation, and on how post-editing of machine produced translation is used in language teaching and translation studies.

2.3 Chapter summary

This chapter has reviewed studies on SLA and on translation in SLA. In brief, research shows that a combination of explicit and implicit learning has been viewed as most beneficial for

language learning. Interactionist SLA theory encompasses input, interaction and feedback, output, and attention, and involves both explicit and implicit learning. Thus, language learning takes place in the process of negotiation for meaning and form through real-time spoken interaction. Nevertheless, learners' L1 and other languages play an essential role in helping to achieve multilingualism. Although translation and translanguaging have different historical and theoretical contexts, multilingual pedagogies incorporating translation and translanguaging practices focus on the use of learners' linguistic repertoires to develop and enhance multilingualism. Whether translation includes translanguaging across different languages or translanguaging embraces translation between languages, translation and translanguaging have been considered useful pedagogical approaches in language teaching. Further, whether or not it is used as a pedagogical approach, translation is naturally involved in multilingual learners' meaning making processes, particularly when the text is linguistically challenging to process for comprehension and production. With advances in digital technology, HLT may often be involved in students' translation processes and have an impact on language learning, which is discussed in Chapter 3.

3 Machine translation and post-editing

In the previous chapter, I have reviewed translation in language learning and teaching. When discussing translation, however, we cannot exclude technology, especially in the era of artificial intelligence (AI). Translation in this study embraces human translation (HT), machine translation (MT), and post-editing (PE) of MT generated texts. By this I mean the processes involved in arriving at MT output followed by human post-editing of MT output, which I abbreviate as MT+PE. MT is central to both research questions (RQ1: How do multilingual learners use MT to support their L2 learning? RQ2: Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?). There has been some research comparing HT and MT+PE in the field of translation studies, while a recent and growing body of literature addresses MT in language education and MT in translation studies.

The primary focus of this chapter is MT in language learning and teaching, and attention is paid to some aspects of MT and PE in translation studies. I begin with a review of MT in language education in Section 3.1, including ongoing advances in MT technology, as well as teaching staff and students' perceptions of MT, and applications of MT in language classrooms. This is followed in Section 3.2 by an outline of debates on MT and PE in translation studies, including a comparison between HT and MT+PE, and an argument for integrating MT technology into translation study programs and academic research for multilingual researchers. Then in Section 3.3 I identify gaps across previous studies and locate a place for this research.

3.1 Machine translation (MT) technology in language education

A contemporary phenomenon attracting attention in higher education (HE) is the use of artificial intelligence (AI) in all walks of life, including language education. In the era of AI, one of its subfields, Human Language Technology (HLT), serves to enable machines to process human languages (Varile et al., 1997). The essential aim of HLT is to provide people of different languages and cultures with equal opportunities to access information. The advent of HLT has generated a new learning mode, in which people can have access to information on the web to gain and share knowledge through the use of online-based resources or technologies. The applications of HLT such as web-based tools (e.g., online translators, online dictionaries, and search engines) and MT have been constantly upgraded and used in different areas, such as translation, and for different needs, such as language learning (Bodomo & Lam, 2006).

Some studies in computer-assisted language learning (CALL) show that language learners use online dictionaries to look up meaning and word form, while adopting corpora or concordancers[9] for collocation and word usage (Lai & Chen, 2015; Yoon, 2016). As search engines collect a considerable body of authentic language data from the web, students use search engines as corpora and concordancers to look for the usage of words, phrases, or grammar for L2 writing (Han & Shin, 2017; Yoon, 2016). A study at an Australian university by Conroy (2010) reveals that most of his students with English as additional language use Google search engines to look for answers to their linguistic questions and to assist their English written production. His findings also show that the students prefer Google Search over concordancers or corpora because Google Search allows them to find language-related answers more effectively and efficiently. The internet allows web users to employ search engines to access various websites for information in different languages. This suggests that the availability of information resources in different languages on the web can facilitate multilingual learning and multilingualism (Ortega, 2017). In addition to online dictionaries, corpora and search engines, online translators, also known as online MT, such as Google Translate, have become unavoidable resources for many multilingual learners in different academic contexts (e.g., Briggs, 2018; Ducar & Schocket, 2018; Heugh et al., 2022).

[9] Conroy (2010) explains, 'A corpus is essentially a large database of texts… A concordancer is software which extracts instances of a specific search word or search phrase from a corpus' (p. 863).

Hutchins (1995, p. 431) defines MT as 'computerized systems responsible for the production of translations with or without human assistance'. Niño (2008) distinguishes between human-aided machine translation and machine-assisted human translation. The former refers to the MT system translating the text with the aid of a human translator to fix lexical and grammatical errors made by MT. The latter, also known as computer-aided translation, refers to a human translator translating the text with the assistance of tools such as MT systems and translation memory systems (e.g., Trados). For example, professional translators may use Trados to store bilingual sentence pairs translated previously and to retrieve as needed in order to facilitate translation processes (Doherty, 2016; Mellinger, 2014). Given that translation memory tools like Trados are expensive and usually used only by professional translators and student translators studying in translation courses, their use is beyond the scope of this research. Online MT (hereinafter referred to as MT) has been significantly involved in the process of language learning (Briggs, 2018; Chon et al., 2020; Lee, 2020; Niño, 2020); hence, it is the main focus in this study. What follows is a review of MT development, teaching staff and students' perceptions of MT, and the applications of MT in language teaching.

3.1.1 Development of MT

Prior to the 21st century, the rule-based approach was the main approach used to develop MT systems, known as rule-based machine translation (RBMT), which was based on linguistic rules to process human language. Owing to the requirements of considerable time and human resources to develop RBMT for each language pair, corpus-based approaches emerged and became prominent between the late 1990s and early 2000s (Bowker & Ciro, 2019). The corpus-based approaches were adopted to develop example-based machine translation (EBMT) and statistical machine translation (SMT), particularly phrase-based statistical machine translation (PBSMT) which has been well-used for decades (Wu et al., 2016).

Recently, neural machine translation (NMT) has emerged at the cutting edge of MT technology (Bowker & Ciro, 2019; Briggs, 2018; Forcada, 2017). The term 'neural' originates in the field of machine learning that provides a context in which artificial neural networks have been developed and the purposes for which they have been developed. Artificial neural networks are intended to mirror the way human brains process information through interconnected circuits of neurons, which work together to solve sophisticated problems (Jain et al., 1996). The distinction between PBSMT and NMT is that the former translates words and phrases separately in one sentence, while the latter treats an entire sentence as one unit to process (Reichert, 2016).

A large body of literature has paid attention to the investigation of the translation quality of state-of-the-art NMT and found substantial improvements in translation quality (e.g., Bowker, 2020; Briggs, 2018; Jia et al., 2019; Moorkens, 2018). Wu and colleagues (2016) selected 500 sentences from Wikipedia and website news and compared the translations of those sentences produced by Google PBMT, Google NMT, and human translation, respectively. The language pairs chosen in that study were English-French, English-Spanish, and English-Chinese. The key findings of the research show: first, Google NMT can reduce 60% of translation errors in the selected language pairs compared to Google PBMT. Second, the output quality of Google NMT is comparable to the human translation quality of translation produced by human translators who are fluent in both chosen languages. Similarly, Hassan et al. (2018) have found that the quality of Chinese to English news translation produced by Microsoft NMT has reached the level of professional human translation[10].

Apart from Google Translate and Microsoft Translator employing NMT systems, Baidu and Youdao are two of the prominent MT tools and widely used in Mainland China (Wang, 2017). As the largest search engine in China, Baidu has offered MT service since 2011 and adopted NMT systems for Chinese-English translation since 2015 (He, 2015). Recently, Baidu NMT systems have employed state-of-the-art models of Transformer[11] (Vaswani et al., 2017) which substantially improves the quality of news translation from Chinese to English and English to Chinese (Sun et al., 2019). Zhu and Zhang (2021), however, argue that when comparing translations of Google, Baidu, Youdao and official translations using error analysis, Youdao performs better in terms of pragmatics.

In addition to the improved translation quality for informational texts as a result of the launch of NMT systems, MT tools are free to access and easy to use for immediate translation between different language pairs on electronic devices, such as computers, tablets and smartphones

[10] During my PhD candidature, I also examined translation of news items on the internet made by Google NMT and Microsoft NMT and found that the English-Chinese translation quality produced by the two NMT systems is comparable to my human translation. However, this does not mean that these two NMT systems can produce translation that is comparable to professional human translation in other text types or genres. It also does not mean that the quality of NMT reached in the Chinese-English pair is matched in other language pairs.

[11] According to Vaswani et al. (2017), 'Transformer' may be the best MT performing model at present; this is a new and simple network entirely based on 'attention mechanisms', completely eliminating previously complex recurrent and convolutional neural networks.

(Ducar & Schocket, 2018; Niño, 2020). MT, on the one hand, has become a popular tool for many students in language learning and teaching contexts (Briggs, 2018; Cancino & Panes, 2021; Lee, 2020, 2022b; Tsai, 2020) and also in EMI contexts (Bowker, 2020; Groves & Mundt, 2021; Heugh et al., 2022). On the other hand, using MT for language learning and academic study has increasingly drawn language teachers' and educators' attention (Ducar & Schocket, 2018; Groves & Mundt, 2015, 2021; Mundt & Groves, 2016). This is reflected in teaching staff and students' perceptions of MT use.

3.1.2 Teaching staff and students' perceptions of MT

Very often, academic teaching staff and students have different perceptions about MT for language learning, which are often the main causes of controversies over whether MT is beneficial or harmful for language learning (Groves & Mundt, 2015; Lee, 2023; Mundt & Groves, 2016) and whether MT should be integrated into the language curriculum (Case, 2015; Jolley & Maimone, 2022; Knowles, 2016). The following is an examination of similarities and differences between teaching staff and students in the frequency and purposes of using MT, opinions on the usefulness of MT, and academic integrity when using MT.

3.1.2.1 Frequency and purposes of using MT

Many studies have indicated that most students of languages make use of MT for language learning to varying degrees, despite MT being discouraged by language teachers and institutions (Briggs, 2018; Cancino & Panes, 2021; Case, 2015; Ducar & Schocket, 2018; Jolley & Maimone, 2015). Clifford et al.'s (2013) survey results showed that 76% of 365 Spanish language students and 88% of 905 Romance language students occasionally used MT, even though the policy of Duke University in the US banned students from using this technology. Two years later, Jolley and Maimone (2015) carried out surveys with 128 students of Spanish at five universities in the US in which 74.22% of respondents reported the use of MT on a frequent (35.94%) or occasional (38.28%) basis. Recently, Briggs (2018) conducted a survey with 80 Korean students of English at a university in Korea. The result showed that a high percentage (85%) of the students reported their use of MT frequently or occasionally inside or outside of the classroom. When asked their purposes of using MT, the students indicated that they mostly used MT to look for lexical items and terminology or to check their L2 output, although they also used MT to help with writing and translation assignments (Briggs, 2018; Clifford et al., 2013; Jolley & Maimone, 2015).

With respect to teaching staff's use of MT, Niño (2009) conducted a survey with 30 language tutors of different languages around the world, and the result showed that 60% of the respondents reported they seldom used MT (several times a year). Regarding the purpose of using MT, 33% indicated that they used it out of curiosity, 20% for producing a draft to write in another language, and 17% for reading texts in another language. Similarly, the survey results of Clifford et al. (2013) showed that only 5% of 43 teaching staff of different languages from several universities in the US indicated that they made frequent use of MT for academic purposes, and 7% reported their frequent use of this technology for non-academic purposes. In another survey with 39 Spanish lecturers from six universities in the US, conducted by Jolley and Maimone (2015), 51.29% indicated that they used MT frequently (28.21%) or occasionally (23.08%) for personal and/or teaching purposes. Interestingly, this result suggests that there are more language teachers who use MT more often, compared with the results of Niño in 2009 and Clifford et al. in 2013. This may indicate that teaching staff use MT more frequently as a result of advances in MT technology.

Nevertheless, the proportion and frequency of students using MT is significantly higher than that of teaching staff. Regarding the purposes of consulting MT, the language teachers in the previous studies demonstrated that they used MT for reading and writing in other languages and for academic and personal use, which are parallel to language learners' purposes for using MT. However, when it comes to students' use of MT, academic staff might have different views, as discussed in the following two sections.

3.1.2.2 Usefulness of MT

Many studies show that students in L2 learning contexts mostly use MT to look for words and find it helpful for vocabulary acquisition (Chang, 2022; Jolley & Maimone, 2022; Lee, 2023). In addition to assisting with lexical items, they find MT useful for a quick understanding of learning content, grasping the gist of learning materials, drafting their written assignments, and helping with writing or translation tasks (Case, 2015; Clifford et al., 2013; Knowles, 2016; Niño, 2009). A study by Heugh et al. (2022) shows that students in the EMI context use MT to look for words and to support their understanding of learning content and their writing process. This shows that language students and EMI students utilise MT in similar ways. A survey conducted by Niño (2020) with 37 students learning different languages (mostly advanced levels, one beginner and a few intermediate levels) showed that 83.80% of the respondents reported improvement in their reading comprehension with the use of MT, and 67% reported that their L2 writing improved with the assistance of MT.

Despite the above positive views of learners on MT, most teaching staff tend to question the usefulness of MT in language learning to some extent (Case, 2015; Ducar & Schocket, 2018; Jolley & Maimone, 2022; Mundt & Groves, 2016). One concern for them is students' excessive reliance on MT that may be counterproductive in language learning in the long term. Academic staff believe that the consequence of overreliance on MT is very likely to reduce learners' opportunities for engaging with the target language they are learning (García & Pena, 2011; Jolley & Maimone, 2015; Knowles, 2016).

Another concern for teaching staff is whether students' language proficiency can judge the accuracy of MT because MT is still not error-free despite its advancement (Bowker, 2020; Niño, 2020). Several factors can influence the quality and accuracy of MT output, including MT systems, language pairs, and text types (Koponen, 2016). A closely related (cognate) language pair, for example among Romance languages, is more likely to produce equivalent MT output than a non-related language pair in which the linguistic features are very different (Case, 2015). In addition, non-literary texts such as informative and technical texts are more likely to produce better MT output than literary texts (Koponen, 2016; Shih, 2016, 2020a). Shih (2020b) asserts that MT cannot precisely transfer the meaning of source texts containing metaphors and cultural connotations from one language into another. As a result, assessing MT output and/or making modifications to inappropriate translation produced by MT has been considered to be essential to overcome its limitations (Niño, 2020).

Most academic staff consider MT to be more useful for advanced level students because they are more able to benefit from using this tool by seeing its merits and pitfalls (Case, 2015; Clifford et al., 2013; Lee, 2022a). Lee and Briggs (2021) investigated MT error correction by Korean students of English with distinct English levels using error analysis and found that advanced level students could correct relatively more MT errors. Lee (2022c) argues, 'While more proficient students perceived MT as a smart CALL tool, using MT was too challenging for low-level students' (p. 184). Beginner or pre-intermediate level students (CEFR A1 or A2) are more likely to be confused by inaccurate MT output owing to their limited target language knowledge for judging MT accuracy.

Nevertheless, García and Pena (2011) adopted MT to support the L2 writing of two groups of basic level students learning Spanish. They found that the students could write more and produce more accurate output through writing in L1 (English) using MT and editing or correcting the MT output in L2 (Spanish) compared to writing directly in Spanish. However,

no MT correction activity was evidenced in the group of beginners from the collected data. The most likely explanation is that beginners are unable to correct MT output into the target language due to their lack of proficiency. Tsai's (2020) study also shows that Chinese-speaking students of English, majoring in an area other than English, benefit more from using MT to improve English writing than those majoring in English; however, whether the students can make judgements about MT accuracy is unclear in the study. Analyses of the literature suggest that more advanced level students are better able to evaluate the accuracy of MT output and to make modifications as needed because of their high linguistic proficiency in both languages (e.g., Lee, 2022a, 2022c).

Nonetheless, the majority of the language lecturers in Clifford et al.'s (2013) study consider the usefulness of MT depends on whether MT is used appropriately and whether students are taught how and when to use it. This result parallels some later studies, showing that the use of MT requires training in order to maximise its usefulness and effectiveness in language education (Bowker, 2020; Ducar & Schocket, 2018; Jiménez-Crespo, 2017; Jolley & Maimone, 2022). The researchers assert that integrating MT into the classroom may help students understand the advantages and disadvantages of MT and how to use MT effectively. Niño (2020) argues that teaching students how to use MT can help them develop independent-learning and problem-solving capabilities and expand their digital literacy. Bowker (2020, p. 28) refers to this as 'machine translation literacy' and contends that not only students but also teachers can benefit from the development of machine translation literacy.

3.1.2.3 Using MT and academic integrity

Most student participants (86.72%) in Jolley and Maimone's (2015) study believe that whether or not MT adoption is considered to be cheating depends on how it is used. They think it appropriate to use MT for translating individual words or checking their L2 output. Similarly, Niño's (2020) study reveals that a high percentage of students (90.9%) learning different languages believe that MT use is not a breach of academic integrity and students should not be banned from using it as a tool. Instead, the students contend that they should have a right to choose their own learning tools and should be assisted to make informed decisions about the selection of online resources. They even argue that if using MT is regarded as cheating, then asking friends of the target language that they are learning to help with their assignments is a form of cheating too.

From the perspective of teaching staff, whereas some language teachers regard MT as a tool but with limitations, some consider using MT to be counterproductive to language learning and associate it with academic dishonesty or plagiarism (Case, 2015; Clifford et al., 2013; Groves & Mundt, 2021; Jolley & Maimone, 2022; Maimone & Jolley, 2023; Mundt & Groves, 2016). In Clifford and colleagues' study (2013), some teachers (42%) view students' use of MT as a violation of academic integrity, while some (37%) hold neutral attitudes towards it and believe that it depends on the types of assignments, how frequently MT is used, and in what context. Not long ago, Groves and Mundt (2021) conducted interviews with eleven academic staff from different disciplines in higher education in the UK. The results show that most of the teaching staff do not regard students' use of MT as academic misconduct. They think it acceptable to use MT for L2 reading, although they become more reserved towards using MT for L2 writing owing to a concern for the development of communication abilities of students. Most recently, a study by Maimone and Jolley (2023) with Spanish instructors across different states in the US reveals that the majority of the participants believe that whether MT use is a breach of academic integrity depends on how students use MT, while a few instructors regard MT use as cheating no matter how it is used.

Analysis of the perceptions of the teaching staff presented above suggests that a lack of consensus among them on MT use in relation to academic integrity leads to uncertainty for students and staff (Case, 2015; Ducar & Schocket, 2018; Groves & Mundt, 2021; Mundt & Groves, 2016). Some researchers, therefore, propose that education policy makers or higher education institutions need to address this issue proactively and provide students and even academic staff with clear guidelines on what is acceptable and unacceptable for the use of MT (Groves & Mundt, 2021; Maimone & Jolley, 2023).

Correa's (2014) study shows that some teaching staff used the error types of MT output, such as word-for-word translation and unnatural expression, as indicators to detect whether students used MT in their written assignments. Niño (2008), however, found that the translation error types made by MT were not much different from those produced by her advanced students. One decade later, Yamada's (2019) study also showed that the error types of translation produced by his advanced students were similar to those made by MT. The results of the two studies indicate that as MT quality improves with the launch of neural machine translation (NMT) systems, it appears more difficult to distinguish translations or written work produced by MT from those made by advanced level students (Chon et al., 2020; Niño, 2020). Nevertheless, language teachers can often spot beginner or pre-intermediate level students' use

of MT in their L2 writing when their output production exceeds expected levels (Ducar & Schocket, 2018; Maimone & Jolley, 2023). However, Maimone and Jolley's (2023) study shows that the language instructors cannot 100% accurately differentiate intermediate level students' written texts with the use of MT from their texts without using MT. This result may suggest that rather than connecting MT use to academic dishonesty, it may be more valuable to guide students on how to use it appropriately.

With the ongoing development of MT technology, several studies show that the quality of MT English output may even be superior to that of the English translation or written production of students with an English major (Briggs, 2018; Lee, 2022b; Tsai, 2019). A study by Groves and Mundt (2015) indicates that the output quality of MT from Chinese and Malay to English has achieved the minimum English proficiency requirement for admission to most universities. Scholars in the field of MT in language education suggest that if MT technology is used appropriately, it can be a beneficial tool for not only assisting language learning and teaching (Groves & Mundt, 2021; Jolley & Maimone, 2022; Lee, 2020, 2023; Mundt & Groves, 2016; Niño, 2020) but also for ensuring equality and justice in multilingual education contexts (Heugh et al., 2022). Learning outcomes resulting from the collaboration between learners and technologies may outperform those achieved by learners without the help of technologies (Jonassen, 1992; Salomon et al., 1991).

3.1.3 Using MT as a pedagogical tool in language classrooms

Since the late 20th century, some academic staff have drawn on MT output as teaching material and encouraged students to make corrections to MT errors or inaccuracies, i.e., post-editing of MT output (Anderson, 1995; Ball, 1989; Kliffer, 2005; Niño, 2008, 2009; Richmond, 2006). In contrast to post-editing of MT output, pre-editing of MT input, i.e., editing source texts for MT, has also been introduced to language learners (e.g., García & Pena, 2011; Niño, 2008; Shei, 2002). As a result of the improvement of MT output, MT can now be used as a tool in the L2 writing and revision process (Chen et al., 2019; Lee, 2020, 2022a; Tsai, 2020).

3.1.3.1 Post-editing of MT output

Post-editing (PE) is most often associated with MT-related tasks involving modifications of MT generated texts (Allen, 2003). Allen refers to PE as a task that requires a translator or post-editor to 'edit, modify and/or correct a pre-translated text that has been processed by a machine translation system from a source language into (a) target language(s)' (2003, p. 297). García (2012, p. 309), however, defines PE as a process in which 'humans amend machine-generated

translation output to achieve an acceptable final product'. Taken together, PE can be viewed as a series of tasks that involve a process of editing, modifying and/or correcting the machine produced text to achieve an acceptable translation. The practice of using MT to generate a text followed by PE is referred to as MT+PE in this current study.

In the context of using MT output as a problematic text to teach language, Anderson (1995) used MT with only 65% accuracy as a tool for the English students of Hebrew to perform MT+PE into L1 English. He suggests that PE from L2 to L1, with an accurate L2 text as a learning model, can help students at the early stage of language learning to evaluate MT output in L1 by using their L1 'intuition' while learning new L2 vocabulary and grammar. Anderson claims that PE from L1 to L2 can be introduced to students when they reach a higher level of L2 proficiency so that students can gain maximum benefits from the practices of PE into L2. Recently, Zhang and Torres-Hostench (2022) provided Chinese students of Spanish at CEFR B2 (upper-intermedate) levels with PE training using ten sentences generated by MT that contained six types of MT errors such as word order and prepositions. They found that the students' PE skills improved according to the pre- and post-test results, and that the PE process requiring attention and reading comprehension might also help language learning.

Furthermore, some teaching staff have integrated MT+PE into the translation classroom for more advanced level learners due to the growing demand for PE in translation industries. For example, Kliffer (2005) introduced MT to intermediate and advanced level students through the activity of MT+PE from L2 French to L1 English in a translation course at a university in Canada. Kliffer found that this activity could help students understand the limitations of MT by critically assessing MT output. In addition, Yamada (2015) required his upper-intermediate level students to undertake MT+PE from L2 English to L1 Japanese in a translation course. The findings of his study showed that most of the students found MT+PE easier than human translation (HT), and that skills required for HT differed from those for MT+PE despite some overlaps between the two. In contrast to MT+PE into the L1, Niño (2008) required her advanced level students to undertake HT and also MT+PE from L1 English to L2 Spanish. She then compared the quality of L2 Spanish translation produced by MT, MT+PE, and HT, respectively. Niño found that the accuracy rate of the L2 translation made by MT+PE was higher than that made by MT and HT. She concludes that the practice of MT+PE not only 'triggers error awareness and provides opportunities for error correction through focus on form and negotiation of meaning', but it also supplies students with 'language autonomy and vocational training' (pp. 44-45). Most student participants in Niño's (2009) study reported that

MT+PE from L1 to L2 helped increase their confidence in L2 written production, especially in the use of L2 vocabulary and grammar.

3.1.3.2 Pre-editing of MT input

Shih (2020a, p. 6) refers to pre-editing as 'revising a source text before it is translated by the MT system'. The purpose of pre-editing or modifying the source text is to increase MT output quality (Bowker & Ciro, 2019; Shih, 2017, 2020b). Pre-editing of MT input has been applied in language teaching since the 1990s (French, 1991; García & Pena, 2011; Niño, 2008; Shei, 2002). French (1991, p. 62) encouraged advanced level students to examine MT output to determine what modification should be made to make the source text 'more machine-friendly'. In so doing, French aimed to teach students MT revision and control of source texts and MT produced texts. Richmond (2006) called the activity of pre-editing of MT 'backwards translation' from L1 to L2. His approach to such backwards translation was to provide the students in his study with a reference translation in L2 that they had already learned and to ask them to adjust the L1 source text of MT until the L2 target text of MT was equivalent to the reference translation. Richmond (2006) concluded that this backwards approach helped students increase awareness of the differences in grammar and sentence structures between languages. It should be noted that Richmond's backwards translation is different to the term 'back translation' in translation studies in which a translated text is translated back to its source/original language to check and ensure translation quality (Son, 2018).

Shei (2002) introduced pre-editing of MT input to Chinese-speaking students in translation and English language programs. The students were required to pre-edit two source texts selected from the web, one in Chinese and one in English, until they obtained the best MT output. They were also asked to pre-edit their own composition in L2 English in order to achieve a better MT output in Chinese. Shei found pre-editing of MT input effective for students to learn to control MT input and observe the changes in MT output. He argued that this activity not only helped the students familiarise themselves with MT, but it also benefited them in learning language and translation.

Revising or modifying the source text (input) of MT is often related to the use of controlled language (CL) (Bowker & Ciro, 2019; Shih, 2017, 2020a, 2020b, 2022). The aim of using CL in MT input is to 'rule out difficult sentence structures and to limit ambiguous vocabulary items in order to achieve accurate translations' (Mitamura, 1999, p. 7). Five CL rules that had the greatest impact on the English to Chinese MT output quality were revealed by Aikawa et al.

(2007). These were: formal style (i.e., avoiding slang or idiomatic expressions), attachment (i.e., avoiding extraposed relative clauses), -ing clauses (i.e., avoiding -ing clauses without an explicit subject), spelling (i.e., avoiding spelling errors), and long sentences (i.e., avoiding sentences longer than 25 words). Aikawa and colleagues (2007) argued that using CL could improve MT quality and post-editing productivity, namely reducing post-editing effort. However, they also cautioned that these findings were based on a statistical MT system developed by Microsoft and the results might differ from other MT systems.

Recently, with the emergence of neural machine translation (NMT) systems, Shih (2020a) investigated the use of CL to improve Google Translate ouput of literary texts from Chinese to English. She proposed several strategies for CL, including making ambiguous words transparent, paraphrasing sentences containing cultural references, using articles and determiners, and adding subjects and objects that are missing in a sentence. In short, the aim of CL use for MT input is to reduce complexity and difficulty at lexical, grammatical, and syntactical levels in order to achieve MT accuracy in meaning, grammar, and syntax.

3.1.3.3 Using MT to improve L2 writing

Since the launch of NMT systems, using MT as an aid to support L2 writing has progressively drawn researchers' and teaching practitioners' attention. They have compared L2 writing results with and without MT use and have found that writing with MT seems to improve writing quality in terms of lexical diversity, syntactical complexity, and grammatical accuracy, compared with writing without the use of MT (Cancino & Panes, 2021; Chen et al., 2019; Chon et al., 2020; Lee, 2020; Tsai, 2022). Also, the studies by Chen et al. (2019) and Chon et al., (2020) reveal that writing with MT seems to reduce the gap in the writing capabilities between advanced and intermediate level students.

Lee (2020) taught Korean students majoring in English to compose their English writing using translation as an approach. The students produced their first draft in Korean and then translated it into English through HT (without using MT) and MT (Google Translate or a Korean MT tool called Papago), respectively, followed by comparing the translations of HT and MT to assist with revisions. Lee found that this process helped students improve their L2 English writing quality by reducing lexical and grammatical inaccuracies. Lee (2020, p. 169) suggests:

> During revision, MT functioned as an individualized feedback system for each student…to show alternatives, which required them to give their word choice more thought and double-check their grammar and expression.

In the same vein, Tsai (2020) adopted similar processes to guide Chinese-speaking students of English, including English and non-English majors, to write an essay by means of translation. Students produced their writing in Chinese and then translated it into English through HT (without the help of any resource) and MT (Google Translate), respectively, followed by comparing the translations made by HT and MT in order to make modifications. Tsai's study showed that MT as a revision tool could improve L2 writing, and enable students to provide more detailed content, more advanced word choice, and fewer inaccuracies in spelling and grammar, particularly for non-English majors. Analyses of the studies by Lee (2020) and Tsai (2020) suggest that using MT for the revision of L2 writing is beneficial for improving writing quality. Nonetheless, in her recent study, Lee (2023) argues that the increased accuracy in L2 writing by improving lexico-grammatical patterns does not guarantee language learning, and that language instructors should have a better understanding of MT, including how to use MT in language teaching.

In summary, whether MT is applied to teach post-editing, pre-editing, or for students to compare against their own written output for making revisions, integrating MT into language classrooms has gained increased weight among language educators to help students understand the benefits and drawbacks of MT while enhancing language learning. Grin et al. (2018, p. 145) recommend that teaching staff should ensure that 'the uses and limitations of machine translation are taught as a part of general training in foreign languages' at this time when MT is widely used for multilingual communication. Teaching students to make effective use of MT may support language learning and learner autonomy (Niño, 2020), where learner autonomy is defined as 'the capacity to take control of one's own learning' (Benson, 2011, p. 58). Learner autonomy closely relates to learner agency, meaning that learners exercise 'power, the will and capacity to act otherwise' in making decisions on the use of strategies in learning (Gao, 2010, p. 154). In this sense, explicit teaching to equip students with MT skills may help to promote learner agency and autonomy. As Chen and Tsou (2023) suggest, guiding students on writing with MT may not only increase 'translingual awareness' but also enhance autonomous learning.

3.2 MT and PE in translation studies

Owing to increases in translation productivity while maintaining translation quality, PE is in high demand in translation industries (e.g., Doherty, 2016; Yamada, 2019). Many scholars and researchers in the field of translation studies have paid attention to the role of MT and PE in regard to translation workflow and translation productivity and quality (Cadwell et al., 2018;

Jia et al., 2019; Moorkens, 2018; Shih, 2020b; Varela-Salinas, 2019). They considered PE to embody important skills and that PE should be integrated into translation programs to equip student translators with PE capabilities.

The European Masters in Translation (EMT[12]) has taken the initiative of integrating MT and PE into the translator training curriculum (Pym & Torres-Simón, 2021; Varela-Salinas, 2019). The EMT competence framework (2022) acknowledges:

> …machine translation (MT) represents a growing part of translation workflows…MT literacy and awareness of MT´s possibilities and limitations is an integral part of professional translation competence (p. 7).

This means that translation programs need to teach translation students how to manage MT tools effectively in translation workflows. Students knowing how to conduct PE to maintain translation quality is also included in the EMT competence framework. In other words, student translators require a wider range of training, which is no longer limited to the practice of translating manually from scratch (i.e., HT); rather it is necessary to include the development of PE capabilities. The National Accreditation Authority for Translators and Interpreters (NAATI) in Australia also gives weight to the revision skills of translators; therefore, translation revision is part of translator certification tests (NAATI, 2015).

As previously discussed, MT output requires human post-editing (PE) to achieve acceptable translation quality. Turner et al. (2015) selected 60 public health materials in English and examined the Chinese translation quality resulting from MT+PE. Their study showed that raw MT output needed to be post-edited by trained post-editors or translators rather than simply by bilinguals without any experience of PE because they might also produce unsatisfactory translations. This means that MT+PE needs specific skills. In Jia et al.'s (2019) study, the student translators with some translating experience indicate that PE is helpful and promising; however, MT+PE and HT are different activities and entail different skills which require training in order to produce adequate translations. Jia et al.'s (2019) finding in translation studies is in line with Yamada's (2014) finding in translation in language teaching, showing that HT capabilities differ from MT+PE capabilities.

[12] EMT is a network of member programs in European countries, and it serves as a partnership project between the European Commission and higher education institutions providing master's programs in translation.

Recently, the use of MT and PE in academic English writing by multilingual researchers has drawn the attention of several scholars in the field of translation studies (Bowker, 2020; Bowker & Ciro, 2019; Escartín et al., 2017; O'Brien et al., 2018). They argue that skills in MT and PE are important for multilingual researchers in scholarly communication and paper dissemination. Given that MT+PE may have an impact on HT, it is worthwhile to consider studies which compare HT and MT+PE in translation and to discuss MT and PE for multilingual researchers.

3.2.1 HT and MT+PE in translation

A number of studies to date have compared the cognitive effort required and time spent both in HT and MT+PE in the field of translation studies (Cadwell et al., 2018; Daems et al., 2017; Jia et al., 2019; Koponen, 2016; Mellinger, 2014; O'Brien, 2006). Jia et al. (2019) drew on a keystroke logging tool, a screen recorder, and retrospective reports to investigate the differences in cognitive effort and time efficiency between HT and MT+PE. To this end, they compared news text translations from L2 English to L1 Chinese produced by HT and MT+PE. The key findings of their study showed that MT+PE using Google NMT systems reduced temporal and cognitive effort in the student translators, compared with MT+PE using Google phrase-based statistical machine translation (PBSMT) systems and HT. A similar study by Daems et al. (2017) concluded that translating news articles from L2 English to L1 Dutch through MT+PE was significantly faster than through HT, and that MT+PE saved more cognitive effort than HT. The findings of Jia et al. (2019) and Daems et al. (2017) are supported by O'Brien (2006) and Mellinger (2014), who have found that MT+PE requires less cognitive and temporal effort than HT. This suggests that MT+PE for news text types can accelerate translation processes and reduce cognitive effort, compared with HT.

With regard to the comparison of translation quality between HT and MT+PE, several studies have shown that L1 translation quality through MT+PE is comparable to that completed through HT (Cadwell et al., 2018; Jia et al., 2019; Koponen, 2016). Daems and colleagues (2017) evaluated 15 English news articles translated into L1 Dutch by 10 student translators and 13 professional translators through MT+PE and HT. They found that the translation quality of texts completed by MT+PE was comparable to that completed by HT in both groups of translators. Carl et al. (2011), however, found that both professional and non-professional translators' news translation quality in L1 Dutch from L2 English through MT+PE is somewhat better than that completed via HT. The results indicate that MT+PE has no negative impact on the quality of news translation from L2 to L1.

Nevertheless, translators' experience of and familiarity with MT may influence their translation productivity and quality through MT+PE (Koponen, 2016). Two studies by Yang and Wang (2019) and Man et al. (2019) suggest that translation students' knowledge and familiarity with MT is strongly correlated with how often they use this tool. This means that a lack of training in MT use may lead to insufficient capability to develop translation technology competence, which has been seen as an essential skill in the workflow of professional translators (Cadwell et al., 2018; Moorkens, 2018; Pym & Torres-Simón, 2021).

3.2.2 MT and PE for multilingual researchers

English is a predominant communicative language in academia despite English L1 speakers only accounting for less than 6% of the world's population (Bowker & Ciro, 2019). Given that English is a lingua franca or what Jenkins (2015) has called 'English as a multilingual franca' between and among people with different linguistic backgrounds, publishing in English seems to be a norm or a requirement for multilingual researchers (Zheng & Guo, 2019). The study by Zheng and Guo (2019) shows how Chinese multilingual scholars have changed from seeing multilingualism as problem to seeing it as resource (see also, Gao & Zheng, 2019). One strategy for multilingual researchers is to draw on their multilingual capability together with online translation tools to make publications in English possible. This shows that translation between languages may serve an important function in academic communication and publication for multilingual researchers (Bowker, 2020; Bowker & Ciro, 2019; Groves & Mundt, 2021). Bowker and Ciro (2019) argue that MT may help scholars and researchers whose L1 is different from English to search for English literature and to assist in assimilation and dissemination of English research papers.

O'Brien et al. (2018) conducted an investigation into using MT+PE to support academic writing in English. Ten multilingual researchers in different academic fields, having English as an additional language, were asked to write a 500-word abstract of their fields of study by means of direct writing in English and MT+PE. More specifically, they were required to write a half of the abstract directly in English and the other half in L1 and then translate that into English using MT followed by their own post-editing for writing quality evaluation. The research findings revealed that MT+PE did not show negative impact on English writing quality, and that half of the research participants reported interest in using MT+PE to support their future academic publishing.

Similarly, Escartín et al. (2017) carried out a survey with 15 Spanish-speaking researchers in the medicine domain to explore whether they used MT and PE as a writing aid to publish their papers in English. Two main findings emerged. First, some participants already used MT for writing in English. Second, the researchers without training in PE could only roughly post-edit their academic papers and their post-edited texts did not attain publishing quality. The implications of the study correspond with those of Kit and Wong (2008), Anazawa et al. (2013), and Bowker and Ciro (2019), indicating the need to support multilingual researchers to develop expertise in using MT and PE to make optimal use of this technology. Kit and Wong (2008) argue that the usefulness of MT cannot simply be determined by how good it is in translation, but more importantly it depends on how it is deployed:

> …the currently available MT technologies, if properly utilized, have been good enough to serve most of the translation demands for the purposes of information access, interchange, and assimilation. Even for the purpose of information dissemination, professional use of MT can minimize one's workload towards publishable translation (p. 320).

In academic settings, multilingual scholars can use MT to gain access to information in other languages and to facilitate written communication for publication and academic exchange. To empower multilingual researchers, training on MT and PE seems advantageous and how to use MT effectively appears to be an important capability which requires development.

3.3 Positioning the current study

Based on the literature review in the previous chapter and this chapter, translation studies and SLA are regarded as two separate academic fields; however, they are closely related when it comes to using translation in language teaching (Carreres, 2014; Colina, 2002; Cook, 2010). When considering that learning a language relates to learning to translate from or into that language, learning languages and learning to translate may have a reciprocal relationship. The practices of translation or translanguaging can be seen when students attempt to understand the meaning of challenging texts in L2 and to make meaning in L2 to complete assignments (e.g., Heugh et al., 2017). In the era of digital technology, MT has been widely used as a resource among multilingual learners in both language learning and teaching and EMI contexts. Although there are connections being made between MT and CALL (one of the areas included in SLA) (e.g., Chang, 2022; Tsai, 2020), there have not yet been clear links made between MT and SLA theory. As indicated in a recent review of MT research by Jolley and Maimone (2022, p. 34), 'connections between language acquisition theory…and MT use are rarely found in the MT literature'. They call for studies focusing on connections between MT use and SLA theory

to help with an understanding of 'cognitive processes that promote language acquisition and the concrete ways in which proposed tasks involving MT facilitate these processes' (Jolley & Maimone, 2022, p. 40).

In addition, academic staff believe that whether using MT is a breach of academic integrity depends on how it is used and in what context. However, few studies have paid attention to how language students use MT, particularly how they employ this technology to mediate meaning between different texts and languages, although literature on both language teaching and translation studies calls for the need to guide students on the effective use of MT. Lee (2023) suggests that language instructors should 'find appropriate methods for using MT with their students' (p. 121). Furthermore, skills in MT and PE have been considered to be important for student translators and multilingual researchers. However, questions about whether MT and PE capabilities are equally important for language students and EMI students, and whether MT and PE can help to advance L2 learning remain unclear, despite MT being a popular tool among students in both language learning and EMI contexts. In exploring connections with interactionist SLA theory and examining how students of Chinese language and EMI students use MT, this study may contribute towards understanding the relationship between MT and PE, and the potential for language learning and EMI study for higher education students with multilingual repertoires.

3.4 Chapter summary

The rapid rise of AI in the first two decades of the 21st century has led to significant advances in MT technology, such that this has become one of the most commonly used online resources for many language students and EMI students. Research shows that teaching staff and students often have different opinions on using MT for language learning in terms of the usefulness of MT and academic integrity. Nevertheless, some language teachers use MT as a pedagogical tool and integrate MT into the language classroom, teaching students post-editing of MT output, pre-editing of MT input, and using MT to assist with L2 writing and revision. However, MT is considered to be more beneficial for advanced level students as their language proficiency in both languages enables them to see the value and pitfalls of MT. Owing to the improvement of MT quality, an increased number of researchers in translation studies have proposed the incorporation of MT and PE into translation study programs. Skills in MT and PE have been considered to be important for multilingual researchers to support academic communication and publication. However, little research has explored the development of expertise in MT and PE in language learning and teaching and EMI contexts. This study builds

on prior research to investigate how multilingual learners in both contexts use MT and whether MT and PE can advance L2 learning.

4 Methodology

The main purpose of this study has been to investigate the potential of machine translation (MT) and post-editing (PE) of MT produced translation to advance L2 learning in the contexts of language learning and teaching and EMI. More specifically, I have sought to understand how multilingual learners in both contexts use MT and how they can use MT to help mediate the proximal equivalence of meaning between the source text/language and the target (translated) text/language. I have also wanted to examine whether MT and PE can serve to advance L2 learning. This study therefore has been driven by the following two research questions:

1. *How do multilingual learners use MT to support their L2 learning?*

2. Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?

To address the research questions, I planned to collect data through two different teaching intervention trials with different student cohorts. The first was in a translation course with advanced learners of Chinese at National Taiwan University (NTU). The second was with a group of Chinese-speaking students who were studying postgraduate degrees through EMI at the University of South Australia (UniSA). The sudden outbreak of COVID-19 in early 2020 with unanticipated international border closures and restricted face-to-face teaching regulations had a significant impact on the planned interventions. The number of participants at each site was greatly reduced: from 15 to 4 in the translation course at NTU, and at UniSA to six volunteers. Face-to-face teaching had to be swiftly changed to online teaching via Zoom. Despite the sudden changes in the research design, the teaching interventions with two small groups of students on the Zoom platform enabled me to collect screen recorded data for observation and to work closely with the research participants. The problems caused by COVID-19 were therefore turned into an opportunity in this study.

In each group, students translated in two directions between English and Chinese and Chinese and English. The first trial intervention for students of the Chinese language focused on translation pedagogy. This involved the use of human translation (HT), MT and PE. The second trial intervention for the EMI postgraduate students (L1 speakers of Chinese) included a collaborative MT and PE tutoring process, also involving the use of HT, MT and PE. More

details about the designs of the two teaching interventions are provided later. The research with the two different groups of participants gave me opportunities to explore the potential of MT and PE in both Chinese language learning and EMI contexts. This allowed me to address the research questions from the unique perspectives of two distinct cohorts of students.

4.1 Research methodology and frameworks

The study was based on action research methodology which allowed me as a teacher researcher to explore students' use of MT and their language learning development when interacting with MT tools during a teaching-learning intervention. This means that teacher and students learned with and from each other about the use of MT, in a reciprocal learning process. The methodological framework was built on an iterative process of reflection-reflexivity-praxis, observations of screen recordings, evaluations of translation samples, focus-group interviews, questionnaires, and follow-up enquiries through email correspondence. This is elaborated below.

4.1.1 Action research

Action research is a critical process which aims at changing researchers' practices, researchers' understanding of their practices and the conditions where the practices take place. In other words, the purpose of action research is to transform what researchers do, think and the ways that they relate to other people and things around them (Kemmis, 2009). Action research in the educational context, also called teacher research, refers to a study where teachers deal with a classroom problem or engage in teaching activities to improve their teaching practice and the learning performance of students (Cranton, 2022). The aim of action research is to improve and make changes to a specific situation. Teacher researchers implement interventions to improve teaching and/or learning in accordance with the practical needs of students (participants). Therefore, one of the advantages of action research in education is to empower teachers to deal with their own classroom issues systematically in a specific teaching-learning context and to focus on the learning needs of the specific group of students.

Norton (2018) argues that action research allows teacher researchers to explore the implementation of innovative teaching methods or curricula as well as the development of students' learning. The findings from action research might therefore be beneficial for curriculum development and pedagogy. Mackey and Gass (2015) suggest that the results of action research for SLA might not be generalisable to a wide range of populations of L2 learning; however, they could provide insightful findings to language educators with similar

concerns in their own teaching practice, and also contribute to building theories of L2 learning processes. In general, action research consists of several steps, notably identifying a problem, designing a plan to address it, implementing the plan, observing the effects of the plan, evaluating and reflecting on the results of the implementation, and modifying future practice (Burns, 2009; Norton, 2018). These steps form an iterative cycle that may not end until the researcher obtains a satisfactory result. Norton (2018) argues, however, that there are no fixed rules to carry out action research but rather there is flexibility depending on the research context.

Reflection plays a fundamental and important role in both Burns and Norton's action research processes. Burns (2009) asserts that reflection and action are inseparable as reflection on implementation (action) is at the core and brings meaning to action research. Schön (2017) defines the difference between reflection-in-action and reflection-on-action and suggests that the former is a reflection on the practice that is happening in an unexpected way, i.e., reflecting while teaching. The latter is a reflection on the practice after it has been completed, i.e., reflecting on the findings and the whole process of implementation for future practice. The key to successful action research may well lie in both reflection-in-action and reflection-on-action.

However, reflection itself as a mental activity does not actively generate reacting practice or action (Feucht et al., 2017), although Schön (2017) argues that reflective practice is not separate from action but instead they are intertwined, like thinking by doing. Brookfield (2017) argues that critical reflection in education forms a sustainable process to examine and verify the teacher researcher's explicit and implicit assumptions of teaching. This critical reflection focuses on a purposeful internal dialogue that contributes to transformative action, namely, reflexivity, which has 'the self-referential characteristic of "bending-back" some thought upon self' (Archer, 2009, p. 2).

According to Ryan (2015), reflexivity is often an interchangeable term with critical reflection or transformative reflection, which entails an action following reflexive practice. Lunn Brownlee et al. (2017) argue that reflection, on the other hand, is a component of reflexivity, while reflexivity requires deep level reflection and the following action. In contrast to reflection, reflexivity needs both reflective thinking and purposeful inner conversations that lead to action or decision making. Feucht et al. (2017) further suggest that reflection transforms to reflexivity when an intentional inward dialogue brings about changes in teaching practice.

The action and changes resulting from reflexivity can be considered an interactive process of reflection and action, i.e., praxis. According to Freire (1970/2018), praxis is a combination as well as an interaction of action and critical reflection. As Freire states, without reflection, action becomes ‘activism’; without action, reflection becomes ‘verbalism’ (2018, p. 87). In addition, Kemmis (2009, p. 4) defines praxis based on the usage of this word from two different perspectives. Firstly, praxis is interpreted as appropriate conduct in a specific situation such as in an educational context; secondly, it can be viewed as individuals’ social collective actions that make history. According to Kemmis (2012), praxis through reflexivity in the teaching context, on the one hand, aims to be appropriate conduct and helpful for students. On the other hand, it is not only influenced by, but also reconstructs the teacher researcher’s epistemic cognition. Professional teaching and sustainable education thus develop through the process of reflection, reflexivity and praxis, which serves as a tool for educators to look into their own pedagogies, understand their own practices, and make necessary modifications to cater to the needs of students (cf. Brookfield, 2017; Freire, 1970/2018; Hofer, 2017).

4.1.2 Action research framework for this study

Based on the above literature, I drew from and adapted the action research processes of Burns (2009) and Norton (2018) together with reflexivity and praxis (Brookfield, 2017; Freire, 1970/2018; Hofer, 2017) to develop a five-phase procedure for this action research study. The phases were: planning, implementation, observation, reflection, reflexivity and praxis, which could be repeated as an ongoing or iterative cyclical process (Figure 4.1).

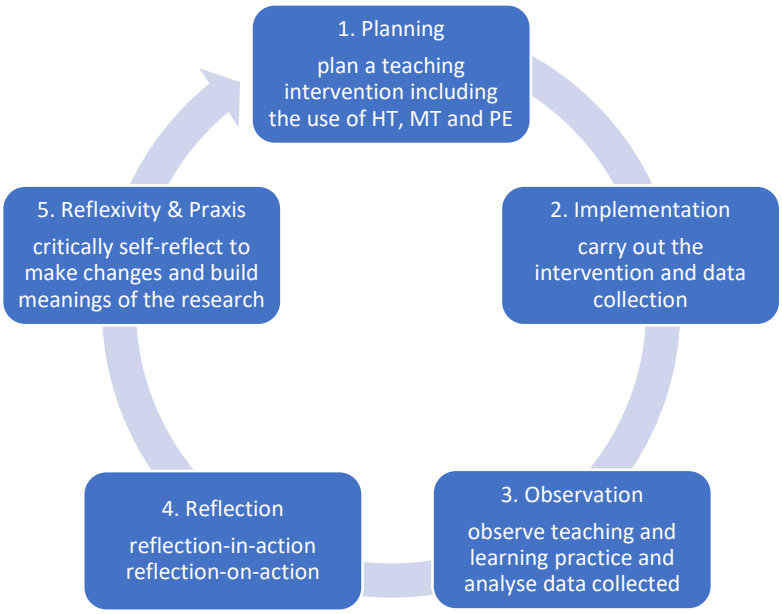


Figure 4.1 A five-phase procedure for this action research study

As presented in Figure 4.1, in Phase One (Planning) I made plans for teaching interventions for the two student groups, identified research methods and prepared instruments to be used for collecting information. Phase Two (Implementation) was to carry out interventions and collect data as planned. The aim of Phase Three (Observation) was to observe teaching and learning practice and analyse information gathered from participants. Reflection in Phase Four encompassed reflection-in-action during the teaching intervention and reflection-on-action after the intervention (Schön, 2017). During teaching practice when I observed any uncertain or unexpected situations, I made timely changes in response (Reflexivity and Praxis). After the intervention, I reflected on the results and findings of the whole teaching implementation, which was then transformed to reflexivity and praxis in Phase Five. This reflexive practice allowed me to understand findings, to build meanings out of the study, and to make modifications and recommendations for further practice.

In this process, I was not only a knowledge provider, but also a learner, learning from and with student participants on their MT use and learning through ongoing reflection, reflexivity and praxis. This procedure deepened my understanding and helped me gain increased insight on the processes involved in MT and PE along with my student participants. It was anticipated that the teaching intervention for the first student group (SG1) could help to modify the planned intervention for the second student group (SG2), although the interventions were different and conducted in different settings. Figure 4.2 presents an overview of this action research design

and procedure. The details of research sites, participants, and the design of the five-phase action research in each group are elaborated in Sections 4.2 and 4.3.

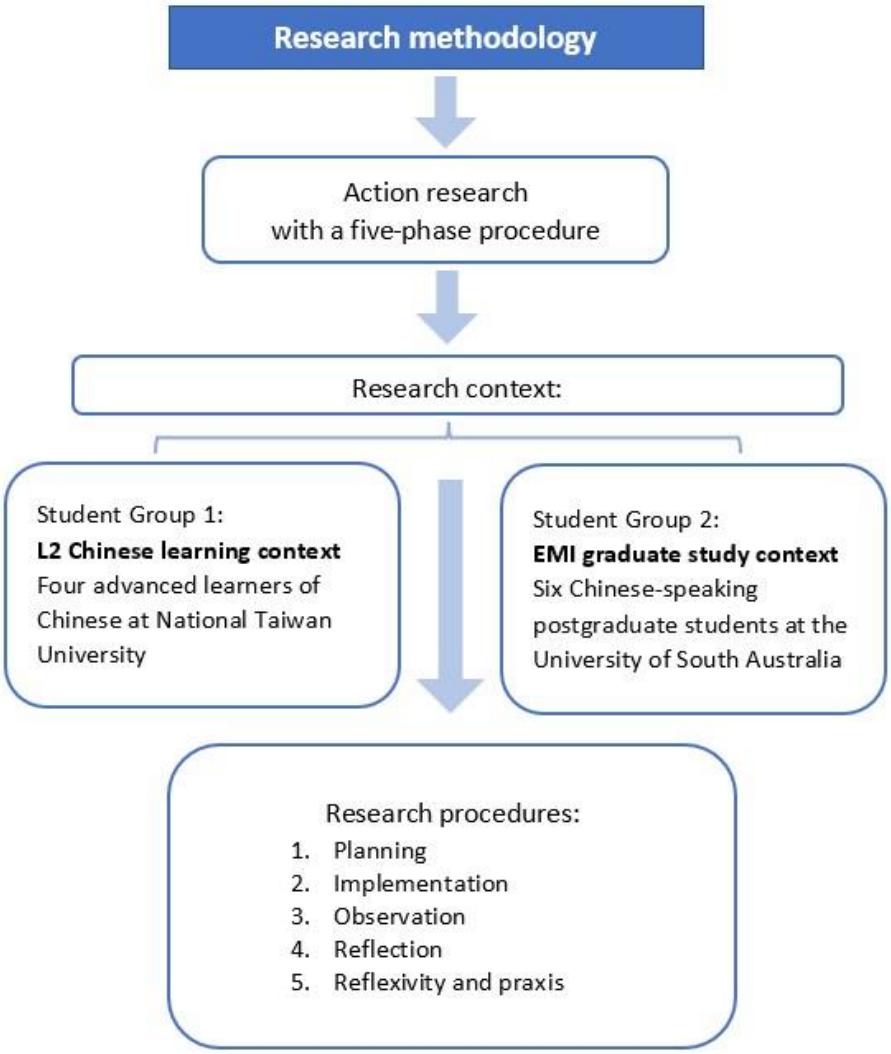


Figure 4.2 Overview of this action research design and procedure

4.1.3 Pedagogical translation framework

As discussed in Chapter 2, in the SLA context pedagogical translation refers to translation activities intended to support language learning. Leonardi's (2010) pedagogical translation framework consisting of three-stage activities, namely, pre-translation activities, translation activities and post-translation activities, aims to develop four language skills, i.e., listening, speaking, reading, and writing. Figure 4.3 below shows a basic structure of Leonardi's framework with translation related activities excerpted from her original work.

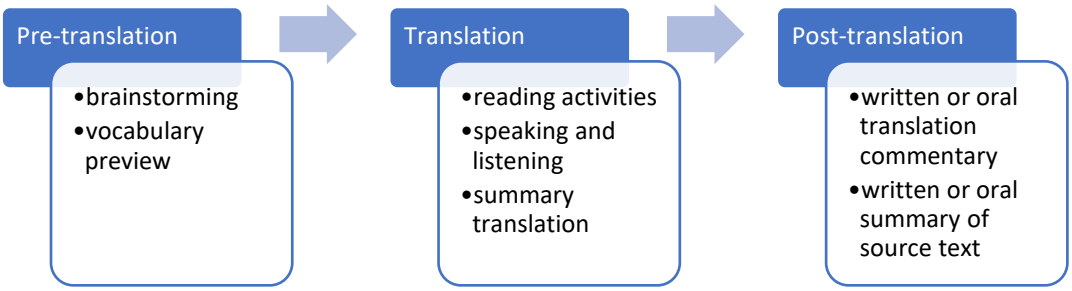


Figure 4.3 Basic structure of Leonardi's pedagogical translation framework (2010, p. 88) [interpreted diagrammatically for this thesis]

However, the teaching intervention involving HT, MT and PE for SG1 was to explore students' use of MT in translation activities. Therefore, I only adopted Leonardi's framework as a skeleton structure and replaced the activities listed in the above figure with activities more suited for the research purposes. Figure 4.4 shows the adapted three-stage activities for each teaching session for SG1.

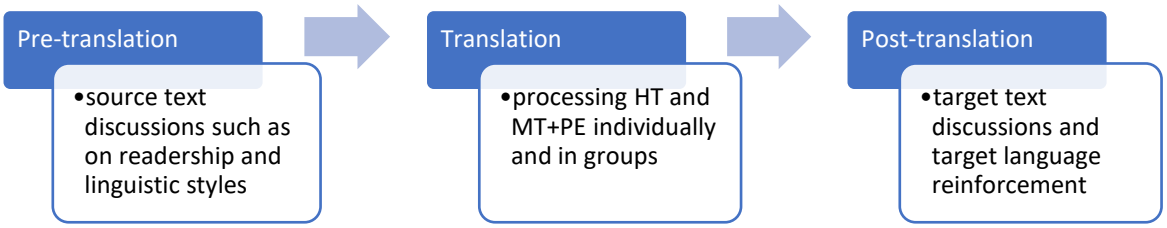


Figure 4.4 Leonardi's framework adapted for the interventions in each session for SG1

At the pre-translation stage, the main activities comprised discussions of the text that was to be translated, i.e., the 'source text'. Students and the teacher discussed the linguistic styles in the source text, the intended readership of the text, and the purposes of translation in particular. At the translation stage, students processed translation through HT and MT+PE, individually and in groups. At the post-translation stage, the class carried out a discussion of the text that had been translated, i.e., the 'target text'. Students and the teacher commented on the meaning transfer between the source text and the target text in terms of grammar, semantics, and pragmatics. It needs to be noted that because the teaching intervention for SG2 was not carried out in a translation course but rather it was a collaborative MT and PE tutoring process, the adapted pedagogical translation framework was not applied in SG2.

4.2 Action Research Study for Student Group1 (SG1)

The intervention for SG1 was undertaken in an eight-week trial translation course, originally designed to be conducted at the International Chinese Language Program (ICLP) of the

National Taiwan University between April and May 2020. As mentioned earlier, COVID-19 necessitated changing on-site face-to-face teaching to an online delivery via Zoom. This resulted in changes to the teaching mode and amendments to ethics approvals, and a four-week delay in starting and ending the intervention in June 2020.

4.2.1 Research site and participants

The research participants were L2 learners of Mandarin Chinese. Previous research suggests that advanced level students are more suited to the practice of MT+PE (Niño, 2008, 2009; Yamada, 2019). Therefore, requirements for participants included fluency in English and advanced proficiency in Mandarin Chinese based on ICLP criteria, and equivalent to CEFR B2/C1 levels.

Potential participants were recruited following the UniSA Human Research Ethics Committee protocols. This included emailing approved UniSA research participant information and consent forms to ICLP colleagues (see Appendix 4.1). ICLP colleagues posted the research information on the ICLP bulletin board and emailed the relevant documents to students who met the participation requirements. ICLP colleagues also advised potential participants of the unique differences between my previous translation courses at ICLP and this pilot intervention. Fifteen ICLP students enrolled as participants in this study in February 2020. However, eleven registered participants affected by travel restrictions in March 2020 withdrew from the study. With only four remaining participants, the sample size was negatively affected. Table 4.1 shows participant baseline data obtained through a pre-intervention questionnaire. The data include academic and linguistic background information. According to Table 4.1, three students (Rory, Maggie, and Amanda) are bilingual speakers, having English as L1 and Chinese as L2. One student (Lisa) is a multilingual speaker, having Dutch as L1 and English, French, and Chinese as additional languages. While Lisa graduated with a master's degree, the other three students graduated with a bachelor's degree in their home countries.

Table 4.1 Background information of the students

Name (Pseudonym)	Rory	Lisa	Maggie	Amanda
Gender	M	F	F	F
Age range	25-34	18-24	18-24	25-34
Home language	English	Dutch	English	English
L2 or additional language(s)	Chinese	English, French, Chinese	Chinese	Chinese
Chinese level	C1	B2	B2	B2
Academic backgrounds	Bachelor of Science graduate	Bachelor of Arts graduate (Chinese studies with a minor in Economics) Master of Arts graduate (Chinese studies with a minor in Economic policy and management)	Bachelor of Science graduate (Biology with a minor in Chinese language)	Bachelor of Arts graduate (Chinese studies)

4.2.2 Research design and procedure

Action research with this group was undertaken through a teaching intervention in a pilot online English-Chinese translation course. The research design was based on the five-phase procedure of action research, including planning, implementation, observation, reflection, reflexivity and praxis.

4.2.2.1 Planning

The aim of the student participants was to advance their study of the Chinese language through translation. According to Leonardi (2010), pedagogical translation is primarily used as a teaching tool to improve L2 proficiency of learners through translation activities. I therefore employed pedagogical translation as a tool to design the L2 translation course involving translation activities of HT, MT and PE. By engaging in a range of translation tasks, the learners were guided to use two or more languages in each of their linguistic repertoires, and to further strengthen their Chinese language knowledge and expertise.

This teaching intervention took place over eight weeks via Zoom, with a total of fifteen sessions consisting of thirty teaching and learning hours (15 sessions x 2hrs = 30hrs). Table 4.2 shows the teaching schedule comprising five teaching phases including data collection. This is elaborated in Section 4.2.2.2 (Implementation).

Table 4.2 Teaching schedules for this translation course

8 weeks (2hrs/session)	Teaching activity & materials	Teaching phases
Session 1	Pre-intervention questionnaire & Pre-intervention task	Phase 1: Introducing basic knowledge of translation to students, including definitions of translation, standards of translation, and classification of translation.
Session 2	Course outline distribution Introduction to translation (incl. HT, MT and PE)	
Session 3	HT exercise from Chinese to English and vice versa	Phase 2: Undertaking HT and MT+PE and trying out the recommended MT tools
Session 4	MT+PE exercise from Chinese to English and vice versa	
Session 5	Chinese to English translation activity via HT and MT+PE (biography)	Phase 3: Comparing HT and MT+PE in translation processes and products; translating materials are selected by the teacher
Session 6	Chinese to English translation activity via HT and MT+PE (folk story)	
Session 7	English to Chinese translation activity via HT & MT+PE (recipe)	
Session 8	English to Chinese translation activity via HT & MT+PE (short novel)	
Session 9	Chinese to English translation activity (prose)	Phase 4: Engaging in more translation practices; translating materials are chosen by students
Session 10	Chinese to English translation activity (prose)	
Session 11	English to Chinese translation activity (news article)	
Session 12	English to Chinese translation activity (short novel)	
Session 13	Post-intervention questionnaire & post-intervention task	Phase 5: Reviewing translation methods by discussing students' translations made in the pre- and post-tasks
Session 14	Review and reinforcement	
Session 15	Focus group interviews	

Regarding the selection of the translating materials, both students and I were responsible for choosing authentic materials/texts to translate. Because I knew what students might have learned (e.g., vocabulary and grammar) based on their language levels, I could select suitable materials that did not greatly exceed their levels. Students' learning interests were also taken into consideration with respect to the selection of materials in this study. For this reason, the students were encouraged to choose source texts. There were eight in-class translation tasks with eight source texts in teaching Phase Three and Four. I selected four texts to translate in Phase Three. After students had become more familiar with HT and MT+PE, each student was given an opportunity in Phase Four to choose a source text (i.e., together the students chose four of these texts). Regarding the source text types, literary and non-literary genres were both

embraced in the course. The literary texts covered folk stories, short novels, and prose, while non-literary texts included biographies, recipes, and news articles, as shown in Table 4.2. Because the translation activities were carried out in class, the length of the source text for each translation practice was limited to 150 words to ensure the possibility of completing the task.

4.2.2.2 Implementation

Following the intervention design, I carried out the teaching practice and data collection. As shown in Table 4.2, the planned teaching intervention comprised five teaching phases as follows:

1) brief introduction to translation, including HT, MT and PE;

2) translation practice through HT and MT followed by PE (MT+PE);

3) comparisons of translations produced by HT and MT+PE;

4) additional translation exercises; and

5) review of translation methods.

Teaching Phase One included a pre-intervention questionnaire and pre-intervention tasks in Session 1, followed by an introduction to translation in Session 2. The introductory translation focused on the definitions of translation, standards of translation, and classifications of translation, including HT, MT and PE in particular. A course outline distributed to the students provided a list of recommended language learning resources including dictionaries, Chinese corpus, and MT tools. I introduced four MT tools with neural machine translation (NMT) systems: Baidu, Google Translate, Microsoft Translator, and Youdao. Two were developed in a Chinese-dominant (Mainland China) environment and two in an English-dominant (US) environment. I selected these after trialling several systems, because they offered comparable and complementary equivalences of quality (accuracy in word usage, syntax and meaning transfer).

Teaching Phase Two (Sessions 3 and 4) was designed to have students practice HT and MT+PE. Basically, HT provided a hands-on exercise for students to translate manually, while MT+PE focused on MT evaluation and making corrections to secure increased accuracy of MT output from Chinese to English or vice versa. Students tried out different MT resources recommended while undertaking MT+PE. Translation techniques such as additions and omissions (Sharma, 2015) were also introduced in this phase.

The aim in Teaching Phase Three (Sessions 5 to 8) was to make comparisons of translations generated by HT and MT+PE. Students were divided into two groups (Group A and Group B) to go through translation activities and experience the difference between HT and MT+PE. As shown in Figure 4.5, students in Group A were assigned to translate the first paragraph of a source text via HT, while students in Group B were required to translate the same paragraph via MT+PE. After completing the translation of the paragraph, students using HT had a discussion with students using MT+PE on their translation processes and products. The students swapped translation methods when translating the second paragraph of the same source text, followed by a discussion on translation through different methods. By doing so, students had an opportunity to translate the same source text by means of HT and MT+PE, and to compare the two methods in translation processes and products.

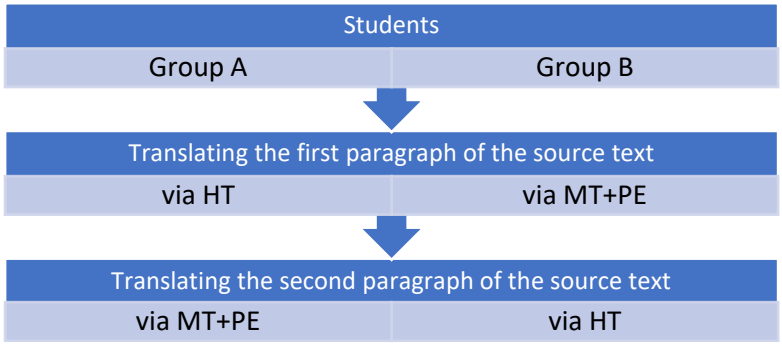


Figure 4.5 Procedures of translation exercises via HT and MT+PE in class

Teaching Phase Four (Sessions 9 to 12) was to provide students with more translation exercises. Students as independent translators could decide their translation methods to complete translation tasks in class. The difference between Phase Three and Four was that I was the one who decided translation methods in Phase Three to ensure that students experienced both HT and MT+PE for making comparisons. However, in Phase Four students could choose their preferred translation method(s). Teaching Phase Five (Sessions 13 and 14) included post-intervention questionnaires, post-intervention tasks, and a review of translation methods used by students in the pre- and post-intervention tasks. Lastly, I conducted a focus-group interview with the four students in Session 15.

As mentioned earlier, Leonardi's (2010) pedagogical translation framework consisting of pre-translation, translation, and post-translation activities was used as a skeleton structure for each in-class translation task (Figure 4.6).

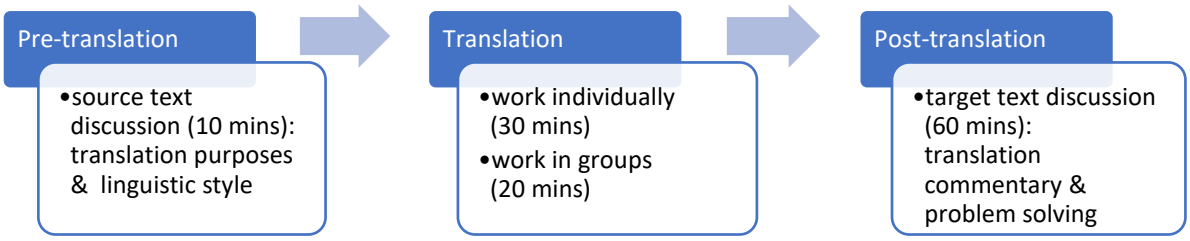


Figure 4.6 The adapted three-stage activities for each in-class translation task

As shown in Figure 4.6, a ten-minute discussion on the source text was set to clarify translation purposes and appropriate linguistic style at the pre-translation stage. After the source text discussion, students individually worked on the assigned translation task for up to thirty minutes, followed by twenty-minutes of group work to discuss their translations. Students could use all available linguistic resources to engage in the group discussion to better understand the source text and modify their translated text. This collaborative learning process provided students with a chance to clarify the meaning of the source text, to check word choice and grammar in their translation, to resolve translation problems, and to determine an appropriate translation to share with the class. At the post-translation stage, a sixty-minute discussion on the target/translated text produced by each group was arranged to provide feedback on the translation outcomes of students. In the target text discussion, students provided comments on their peers' translation. My role was to guide the whole process, to give feedback on students' translations, and to clarify Chinese vocabulary and grammatical points that seemed to be challenging for students.

In general, the teaching and learning process in this intervention was built on a student-centred and teacher-guided collaborative learning approach. Collaborative (or group) learning engaged students in intentional group activities that I designed for meaningful learning purposes (Barkley et al., 2014). Students engaged in translation activities through HT and MT+PE individually and collaboratively in class. They independently completed translation through assigned and self-decided translation methods prior to working in groups to come out with solutions to translation difficulties and to make a better translation. This collaborative learning could encourage learners to listen carefully to the comments of group members, to re-evaluate their own understanding of the source text, and to self-assess their translated target text.

In relation to data collection, the methods used to gather data included pre- and post-intervention questionnaires, screen recordings of pre- and post-intervention tasks, students' translation samples of pre- and post-intervention tasks, and focus group interviews. I also

carried out a follow-up enquiry through email correspondence with one student to further understand any changes in the frequency of using MT and opinions on MT and PE after the intervention. The procedure for the teaching practice and data collection is shown in Figure 4.7.

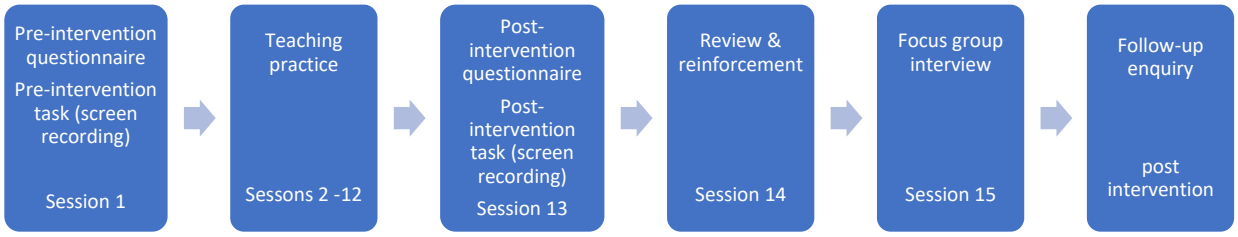


Figure 4.7 Procedure for the teaching intervention and data collection

In this action research, I adopted triangulation[13] of more than one research method and data source to address the research questions from different dimensions, for the purpose of having a more comprehensive understanding through this study (Burns, 2009; Flick, 2019; Saldaña, 2011). The aim of using two or more methods was to know more and generate complementarity between varied data results (Moran-Ellis et al., 2006), because different research methods might reveal different facets of reality or phenomena (Noble & Heale, 2019). As such, I used different methods to complement one another so as to know more and to gain a more rounded understanding of the research focus. These included pre- and post-intervention questionnaires, translation samples of pre- and post-intervention tasks, screen recordings of pre- and post-intervention tasks, and focus group interviews.

Pre- and post-intervention questionnaires

The types of questions in a qualitative questionnaire can vary, including open-ended and closed-ended forms, depending on how the researcher wants to analyse the data (Farrell, 2016; Jansen, 2010). I adopted pre-intervention questionnaires to collect baseline data on the student participants, specifically 1) students' background information, such as gender, age, language repertoire, target language levels, and academic backgrounds; and 2) pre-intervention

[13] In the social sciences, data triangulation is traditionally used to compare data obtained from varied research methods to ensure accurate findings and defensible data analysis. Some researchers however believe that data triangulation is to understand a phenomenon from different dimensions, and that different data sources can be complementary and offer researchers a more comprehensive understanding of their study (Moran-Ellis et al., 2006).

frequency of students' use of MT and their views regarding MT and PE. A five-point Likert-scale rating design was used to understand students' frequency of MT use and views on MT and PE prior to the intervention. The post-intervention questionnaires repeated these questions in order to compare pre- and post-intervention responses. To further understand students' views of MT and PE, three open-ended questions were added to the post-intervention questionnaires to offer students opportunities to add any further comments or suggestions they might have (see Appendix 4.2 Questionnaires (SG1). The questionnaires were used to address RQ1 (How do multilingual learners use MT to support their L2 learning?) and RQ2 (Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?).

Translation samples of pre- and post-intervention tasks

The pre- and post-intervention tasks required the translation in 90 minutes of two 100-word texts from Chinese to English and two 100-word texts from English to Chinese. Students were allowed to use the internet to access any online resources when translating, although the use of MT was not emphasised (see Appendix 4.3 for task instructions and the four source texts). The translation materials were excerpted from two Chinese articles (a magazine article and an idiomatic story) and two English articles (a biography and a short novel). The excerpts for the pre- and post-intervention tasks were not identical but extracted from the same articles, except for the Chinese idiomatic story. The length of the Chinese idiomatic story for the pre-intervention task was around 100 words, therefore, another version of the same story with a similar level of difficulty was selected for the post-intervention task. After completing the translation tasks, the students were required to email their translations to me as part of data collection for assessing their translations made before and after the intervention. A total of thirty-two translation samples from the pre- and post-intervention tasks (8 texts x 4 students = 32 texts) were collected. I used Angelelli's (2009) five-point-scale rubric to evaluate and score these texts. This is illustrated later in Section 4.4 (data coding and analysis). The scoring data were used to compare changes in the scores of students' translations before and after the intervention. The data were used to answer RQ2 (Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?).

Screen recordings of pre- and post-intervention tasks

To explore how the students made use of MT, I needed to examine their translation processes. Screen recordings on Zoom were employed to capture data on participants' translation processes for observation. The method of screen recordings was expected to be more accurate

than other methods such as recall interviews. Think-aloud protocols had been used in similar studies, but they were used to record participants' concurrent verbalisation of their thinking as they undertook translation, so that their translation behaviour could be analysed (Krings, 2001). The present research, however, intended to explore participants' entire translation processes, particularly their interaction with MT, rather than to record their thinking. In addition, Hancock et al. (2001) suggest that observation could be used as a tool to collect more reliable data. Hence, I anticipated that observations of screen recordings could complement questionnaires and focus group interviews, because the former could display what participants actually do with MT, while the latter could only show what participants think they do. As such, I carried out 90-minute one-on-one sessions via Zoom with each of the four students to collect screen recording data of the pre- and post-intervention tasks. Screenshots were also employed to capture visual data from screen recordings to illustrate students' use of MT while complementing textual description. As Burns (2009, p. 72) argues, images or pictures are 'more powerful than words…[they] are an excellent way of supplementing your observation notes'. The screen recording data were used to answer RQ1 (How do multilingual learners use MT to support their L2 learning) and RQ2 (Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?).

Focus group interviews

Discussing or interviewing with research participants could effectively document their perspectives and thoughts about personal experiences 'in their own words' (Saldaña, 2011, p. 32). Interview data directly obtained from participants' perspective could complement observation data derived from the researcher's lens. Therefore, a two-hour semi-structured focus group interview was employed to offer an opportunity to discuss students' perceptions and experiences of using MT and PE and their opinions on MT and PE (see Appendix 4.4 for the interview questions). The student participants mainly chose the Chinese target language to communicate in the interview, although both English and Chinese languages were allowed and encouraged. The interview was recorded, transcribed, and then translated into English by me. The transcripts and English translations were checked back with participants to ensure the accuracy of the content. The interview data were used to address RQ1 (How do multilingual learners use MT to support their L2 learning?) and RQ2 (Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?).

In summary, the collected qualitative data comprised pre- and post-intervention questionnaires, translation samples of pre- and post-intervention tasks, screen recordings of pre- and post-intervention tasks, and focus group interviews. The questionnaires covered a small amount of numerical data from responses to rating questions, which were used as supplementary data to compare the results before and after the intervention. Saldaña (2011) advises that numerical data can serve a supporting function in a qualitative study. In addition, a follow-up enquiry was conducted through email correspondence with one student to further understand any changes in the frequency of MT use and opinions on MT and PE. Table 4.3 shows a summary of data collected from Student Group 1 (SG1).

Table 4.3 Summary of data collected from SG1

Data collection	Artefacts/ Instruments	Details
Questionnaire	Pre- and post-intervention questionnaires	8 questionnaires (2 X 4 students), both pre- and post-surveys included closed-ended questions, and the post-survey also included open-ended questions
Translation sample	Translations made in pre- and post-intervention tasks	32 texts (8 texts X 4 students)
Screen recording	Zoom screen recordings of pre- and post-intervention tasks	12 hrs screen recordings (90 mins X 4 students X 2 tasks)
Focus group interview	Recordings and transcripts	2 hrs interview transcription
Email correspondence	Email	1 student providing responses

4.2.2.3 Observation

During the observation phase, I observed and analysed student learning and practice. I followed Burns' (2009) four-step process of data analysis for action research to code and analyse data from both student groups. This is discussed further in Section 4.4 (Data coding and analysis) together with Student Group 2 (SG2).

4.2.2.4 Reflection

I reflected on any unexpected teaching and learning situations (i.e., reflection-in-action) during the intervention and reflected on the results of preliminary data analysis (i.e., reflection-on-action) after the completion of the intervention. The reflection phase allowed me to gain a better understanding of the implementation of the teaching intervention. This also prompted me to carry out a follow-up enquiry through email communication to clarify answers after the end of the intervention. Examples of my reflection practice are given in Table 4.4 below. I subsequently turned reflection into reflexivity and praxis to make necessary changes to the ongoing teaching intervention and to make recommendations for further teaching practice.

4.2.2.5 Reflexivity and praxis

Reflection-in-action was further transformed to reflexive practice that helped me make immediate changes (praxis) to any ambiguous or unsatisfactory teaching practice during class sessions. Similarly, reflection-on-action was turned into reflexivity that led to changes taking place after class sessions. This reflexive practice allowed me to make modifications to the teaching intervention for SG2. Table 4.4 illustrates how I turned reflection in my reflective journal into reflexivity and praxis during and after the intervention.

Table 4.4 Examples of turning reflection into reflexivity and praxis for SG1

- **During the teaching intervention**
  1. **My reflection:**
     When processing MT+PE from L2 Chinese to English in class, some students proposed that MT output would influence their final translation products in terms of meaning transfer and sentence structure, and that it was important to maintain the sense and essence of the source text in the final products.
     Reflexivity → praxis:
     Using at least two MT resources to double check MT output might be helpful to ensure MT accuracy in meaning transfer while having various words and sentence structures provided by MT tools to compare. So, I advised students that they could use two or more MT tools to cross-check and cross-reference MT output, and that whenever using MT they need to carefully evaluate MT accuracy based on the source text, rather than by simply reading and editing MT output.

- **After the teaching intervention and data evaluation**
  I found an interesting situation from screen recordings: Although MT tools provided accurate lexical choices, students did not accept correct translations. Instead, they changed the suitable translation produced by MT into an inaccurate one.
  Reflexivity → praxis:
  In the pre-intervention tasks, students sometimes seemed unable to judge the accuracy of MT output in L2 Chinese and did not trust MT Chinese output. In addition to the suggestion of using different MT tools for cross-checking, for future teaching practice (with SG 2), I need to recommend that students should make sure MT output is inaccurate or unsuitable before making any changes to it.

  1. **My reflection:**
     The observation results of screen recordings showed that when students translated through HT, they would use MT+PE to solve translation problems and/or use MT output to compare with their translation when making revisions. In the focus group interview, students indicated that using HT or MT+PE depended on text types and their intentions. If they intended to learn Chinese language, they would use HT; however, if they just wanted to produce a translation quickly, they would choose to use MT+PE. The assessments of students' translation samples showed that the quality/accuracy of translation through MT+PE outperformed that through HT.
     Reflexivity → praxis:
     Based on the above findings, students consider HT a useful tool to learn L2 Chinese, however, MT+PE seems to help them overcome linguistic difficulties in translation and to improve translation quality or accuracy. In addition, checking translations made by HT with MT output seems helpful for revising and improving translation outcomes. Therefore, on the basis of findings, it seems that using HT, MT and PE as complementary strategies would be useful for language learning while

ensuring greater accuracy in translated texts. I should therefore emphasise using HT, MT and PE as complementary strategies in future teaching practices, including the intervention for SG2.

2. **My reflection:**
   Students completed eight translations in class, four from Chinese to English and four from English to Chinese.
   Reflexivity → praxis:
   How could students best review the vocabulary and grammar in those translation tasks? I plan to ask students to create a word bank for themselves after the completion of each translation task in the future teaching practice. The word bank should include unfamiliar words, phrases, grammar, and sample sentences that show the correct use of vocabulary and grammar. I think this might help students review what they have learned more efficiently and develop their translation portfolio.

As shown in Table 4.4, the process of the reflection (surface level) and reflexivity (deeper level) for SG1 served to alter the teaching intervention for SG2. In summary, through this reciprocal learning process I understood and learned about four students' strategic use of MT and PE to assist with translation, and the students learned how to translate, from me and peers. This teaching intervention particularly drew my attention to guided teaching on how to use multiple MT tools to cross-check MT output and evaluate MT accuracy, and how to use HT, MT and PE as complementary strategies to help with language learning and translation.

4.3 Action Research Study for Student Group 2 (SG2)

The intervention for SG2 was undertaken through pilot collaborative MT and PE tutoring. This was initially designed as a face-to-face intervention at UniSA. As with SG1 this was changed to an online Zoom process (March - October 2020) after the first tutorial session.

4.3.1 Research site and participants

Research participants were recruited following the UniSA ethics approval and protocol for this study (see Appendix 4.5 for participant information and consent forms). Participants were required to be Chinese-speaking students enrolled in postgraduate degrees at UniSA and interested in using MT and PE to strengthen their academic use of English. All postgraduate international students at UniSA are required to have an IELTS 6.5 proficiency score or equivalent in English (e.g., CEFR B2) for admission to the university. Six students from different academic units signed up to participate in this study. Table 4.5 below shows the background information of the six students collected through the pre-intervention questionnaire (including language abilities and UniSA study programs). As shown in Table 4.5, three students, Yun, Ying and Xiang, have three languages in their linguistic repertoire. Qing, Lian

and Peng indicated two languages (Mandarin and English) in their repertoire, although it is also commonplace for Mandarin-speaking students to have at least one heritage Chinese language (dialect). Given that all six of these students have at least two languages, all are considered multilingual here.

Table 4.5 Background information of the students

Name (Pseudonym)	**Qing**	**Yun**	**Lian**	**Ying**	**Peng**	**Xiang**
Gender	F	F	F	F	M	F
Age range	25-34	25-34	35-44	18-24	25-34	25-34
L1	Mandarin	Mandarin	Mandarin	Mandarin	Mandarin	Mandarin
L2 or addition language(s)	English	English, Taiwanese	English	English, Jiangbei hua	English	English Xinhuang hua
English level	B2	B2	B2	B2	B2	B2
Study program	Master of Teaching (Early Childhood)	Master of Social Work	Master of Research (Business)	Master of Teaching (Early Childhood)	PhD in Architecture	Master of Education (TESOL)

4.3.2 Research design and procedure

The intervention with this group of students was also conducted based on the same five-phase action research procedure as with SG1, that is, planning, implementation, observation, reflection, reflexivity and praxis.

4.3.2.1 Planning

The aim of students in this group was to acquire content knowledge in their fields of study and to learn English. The aim of this intervention, therefore, was to guide students on how to make use of MT and PE to support their postgraduate study through EMI, and to encourage students to exchange experiences of their use of MT. This pilot MT and PE tutoring intervention comprised HT, MT and PE activities during five one-hour sessions. As this was a trial tutoring process rather than a formal course, the meeting dates and times were scheduled based on mutually convenient agreements between student participants and me. The MT tools recommended for SG1 were also those for SG2: Baidu, Google Translate, Microsoft Translator, and Youdao. As this intervention was based on collaborative teaching and learning methodology, my role was not as the main information provider, but as a learning facilitator. I showed the EMI postgraduate students how to use HT, MT and PE to help with their academic reading and writing in English, using findings from SG1 and my own experience of using MT from the start of the present study. Students in this collaborative group were also invited to demonstrate how they used MT during their postgraduate study. The translation materials used

for demonstrations were students' working texts in their fields of study. Details of the tutoring activities are discussed below.

4.3.2.2 Implementation

Following the teaching reflection and reflexivity process for the SG1 Action Research Study in mid-June, I immediately made modifications to the original teaching plan for SG2 from the third tutorial session in late-June. The initial teaching design that focused on MT followed by PE (MT+PE) activities was amended to guiding students using HT, MT and PE as complementary strategies to support their postgraduate study, as previously mentioned. The revised teaching implementation together with the data collection procedure is displayed in Table 4.6.

Table 4.6 The revised teaching implementation and data collection procedure for SG2

Tutorial sessions 1hr/ session	**Tutoring activities**	**Data collection**
Session 1 (March)	• Distributing pre-intervention questionnaires • Sharing experience of making use of online resources for English learning, including MT tools and dictionaries • Introducing HT, MT and PE to students by requesting them to write a 100-word introduction to their fields of study in Chinese and then translate to English through HT, MT, and MT+PE	• Pre-intervention questionnaire
Session 2 (April)	• Engaging students in MT evaluation and modification activities with different MT tools	No data collected
Session 3 (June)	• Showing students how to use HT, MT and PE as complementary strategies for academic reading and writing • Two students showcasing using MT to complete Chinese to English translation and using MT+PE from Chinese to English	• Screen recording of students' demonstration with explanation, and tutorial discussion with peers
Session 4 (August)	• Showing students how to evaluate MT accuracy in the practice of MT+PE • Two students demonstrating using MT to check their own summarised texts and using MT+PE for paraphrasing	• Screen recording of students' demonstration with explanation, and tutorial discussion with peers
Session 5 (September)	• Re-demonstrating using MT to check HT and how to evaluate MT accuracy • Two students demonstrating using MT for reading and paraphrasing	• Screen recording of students' demonstration with explanation, and tutorial discussion with peers

Post Intervention (October)	• Distributing post-intervention questionnaires • Focus group interview with five students • Individual interview with one student who could not participate in the focus group interview • Follow-up enquiries by email correspondence	• Post-intervention questionnaire • Focus group and individual interview • Email correspondence

As shown in Table 4.6, the tutorials were held on a monthly basis, however, no meetings were scheduled in May and July owing to a combination of COVID disruptions and time conflicts between participants. In the first tutorial session, I introduced HT, MT and PE to students by asking them to write a 100-word text in Chinese to introduce their own fields of study and then to translate this text into English through HT and also MT+PE. The students were asked to use one of the recommended MT tools to complete MT+PE. By translating through HT and MT+PE, they were expected to gain a basic understanding of the differences between HT, MT and PE in terms of translation processes and products.

In the second tutorial, I engaged students in MT output evaluation and modification by means of MT+PE activities with the four recommended MT tools (Baidu, Google Translate, Microsoft Translator, and Youdao). This was designed to emphasise the importance of using MT cautiously and critically. The third tutorial was to guide students how to use HT, MT, and PE as complementary strategies to support academic reading and writing in L2 English. Specifically, I showed students how to use MT to check their English reading and writing and to help with revisions, and how to use MT+PE to support HT. In addition to my demonstration, one student showcased how he used MT to support translation from Chinese to English. Another student demonstrated how she processed MT+PE from Chinese to English. All students participated in tutorial discussions about the demonstrations.

In the fourth tutorial, I showed students how to evaluate MT accuracy when undertaking MT+PE because the demonstration of the student in the previous tutorial showed a difficulty with the task. In addition, two students demonstrated and explained their processes in this session, one focusing on using MT to check her summary of academic texts in her English writing and the other using MT+PE for paraphrasing. All students participated in tutorial discussion about their peers' demonstration. As the fifth tutorial was the last session, I re-demonstrated how to use MT output to compare with HT output and how to evaluate MT output using multiple resources. In this session, one student showed how she used MT for academic

reading, and one demonstrated how she used MT for paraphrasing. Again, all students engaged in discussion of the demonstrations.

As previously mentioned, multiple research methods were used for data triangulation to answer the research questions from different dimensions and to have a more comprehensive understanding of this action research. As shown in Table 4.6, pre-intervention questionnaires were distributed to collect baseline data of the student participants in the first tutorial. These included students' background information and closed-ended questions in relation to students' frequency of using MT and opinions on using MT and PE. The questionnaire content for this group of students was equivalent to that for SG1 (see Appendix 4.6). Students' demonstrations and explanations of their MT use and subsequent tutorial discussions between tutorial sessions 3 and 5 were screen recorded via Zoom. In all, two-hour screen recordings (20 minutes X 6 students) were collected for transcription.

After the completion of the intervention, post-intervention questionnaires with the same questions were distributed so that I could compare students' frequency of using MT and opinions on MT and PE before and after the intervention. As with SG1, three open-ended questions were added to the post-intervention questionnaires to better understand students' thoughts on MT and PE. I also conducted a 90-minute semi-structured focus group interview with five participants and a 50-minute semi-structured individual interview with one participant who could not join the focus group interview (see Appendix 4.4 for interview questions). Whereas both English and Chinese were encouraged, like the student participants in SG1, SG2 students mostly chose the target language (in this case, English) to communicate during the interviews. The interviews were recorded and transcribed. I translated the transcription to English if the language used was Chinese. The transcripts and translations were checked back with participants to ensure the accuracy of the content and intended meaning. In addition, I carried out follow-up enquiries through email correspondence with three students to understand more about any changes in the frequency and opinions of using MT and PE.

In summary, the collected qualitative data included pre- and post-intervention questionnaires, screen recordings of students' demonstrations with explanations and tutorial discussions involving all students, one focus group interview, and one individual interview. The questionnaires rendered a small body of numerical data from closed-ended responses. These were used as supplementary data to compare the results before and after the intervention. Table 4.7 shows a summary of data collected from Student Group 2 (SG2).

Table 4.7 Summary of data collected from SG2

Data collection	Artefacts/ Instruments	Details
Questionnaire	Pre- and post-intervention questionnaires	12 questionnaires (2 X 6 students), both pre- and post-surveys included closed-ended questions, and post-survey also included open-ended questions
Screen recording	Zoom screen recordings and transcripts	2 hrs recording transcription (20 mins X 6 students)
Focus group/individual interview	Recordings and transcripts	140 mins interview transcription (90 mins for a focus group & 50 mins for an individual interview)
Email correspondence	Email	3 students providing responses

4.3.2.3 Observation

In the phase of observation, I observed the ongoing teaching and learning practice during the intervention and analysed the data collected. As displayed in Table 4.7, the information gathered included multiple data from questionnaires, screen recordings, focus group/individual interviews, and email correspondence. As mentioned earlier, Burns' (2009) four-step process of data analysis for action research was used as a guide to code and analyse data collected. This is elaborated in Section 4.4 (Data coding and analysis).

4.3.2.4 Reflection

I reflected on the teaching practice during (i.e., reflection-in-action) and after (i.e., reflection-on-action) each stage of the intervention and data collection. Reflection during the teaching intervention allowed me to understand what students had already learned and what they had not learned. Reflection after the teaching intervention helped me to gain a better understanding of the entire teaching intervention. An example of my reflections is shown in Table 4.8 below. Once again, turning reflection into reflexivity and praxis to make transformations was an essential phase in this action research study.

4.3.2.5 Reflexivity and praxis

Reflection-in-action was further turned into reflexive practice that helped me make timely changes (praxis) to any ambiguous or not entirely satisfactory teaching and learning activities over the period of the study. Reflection-on-action was transformed to reflexivity that allowed me to make modifications and recommendations for future teaching practice. Table 4.8 shows examples from my reflective journal notes on how I transformed teaching reflection into reflexivity and praxis during and after the intervention.

Table 4.8 Examples of turning reflection into reflexivity and praxis for SG2

- **During the teaching intervention:**
  1. **My reflection:**
     One student chose MT (Youdao) to translate an online paragraph-long text in Chinese into English, followed by post-editing (PE). However, she seemed hesitant and not sure whether the changes/modifications she made to MT output were suitable or appropriate.
     Reflexivity → praxis:

     Using two or more MT tools together with other online resources such as dictionaries to cross-check MT output might be useful to help judge MT accuracy and edit MT output. Also, rather than randomly choosing one MT output as a basis to do PE, it might be more efficient to select a relatively better MT output from several alternatives before undertaking PE. So, I advised that students could use two or more MT tools to translate texts, and then select their perception of a better translation as a draft to process PE. They could also refer back to other translations produced by MT tools and consult dictionaries when evaluating MT accuracy and editing MT output.

  2. **My reflection:**
     One student used MT (Google Translate) output in English to compare her own writing in English for making revisions. However, the student mentioned that she needed more translation alternatives to help with word choice and grammar, but she had trouble using Youdao and Baidu translators because she could not read simplified Chinese.
     Reflexivity → praxis:

     Different MT tools may provide varying translations so one can have more translation alternatives (e.g., word choice and sentence structure) from different MT tools. So, I advised that they could consult various MT tools to obtain more translation alternatives and use them as points of reference when needed, and that the four MT tools recommended can translate texts from simplified Chinese to traditional Chinese and vice versa.

- **After the teaching intervention and data evaluation**
  1. **My reflection:**
     The screen recordings of students' demonstrations and tutorial discussions showed that one student used MT to translate difficult academic texts in English into Chinese, followed by PE and paraphrasing in Chinese. She then used MT to translate the post-edited and paraphrased Chinese text back to English, followed by PE to complete paraphrasing. The other student, however, used different MT tools to obtain different MT outputs in English as points of reference and then made a combination of different MT outputs to finish paraphrasing.
     Reflexivity → praxis:

     PE and paraphrasing in Chinese in the first example can demonstrate the student's understanding of the academic text in English and can also reduce similarity to the original text. The practice of MT+PE between English and Chinese also seems to increase opportunities for multilingual learning and enhancing multilingual capabilities. In the second example, patching different MT outputs together without the process of moving back and forth between languages and paraphrasing in her own words seems to render a paraphrased text that has high similarity to the original text in sentence structure. This may lead to concerns relating to potential breaches of academic integrity. Therefore, using MT+PE to support understanding and paraphrasing can be suggested as a strategy and integrated into pedagogy, especially for teaching academic writing.

The value of teaching reflection (surface level) and reflexivity (deeper level) during the intervention was that these practices helped me understand the teaching and learning problem immediately so that I could take actions (praxis) to solve the problem more effectively. Similarly, reflexive analysis of the research findings was carried out after completing the teaching intervention to understand the research more deeply, to build meanings from the research, and to provide possible modifications and recommendations for future study and teaching practice.

4.4 Data coding and analysis

The collected data from both student groups were coded and analysed using an inductive approach. According to Burns (2009), an inductive approach is to:

> …scan the data carefully, usually several times over, to see what categories suggest themselves, or 'merger', from the data…In other words, the data give us the categories (p. 107).

As a guide for data coding and analysing, I adopted Burns' (2009) four-step process of data analysis for action research, which consists of assembling data, coding data, comparing data, and building meanings and interpretations.

4.4.1 Assembling data

The first step was to gather all data collected and then to scan the data to look for patterns in relation to the research questions. Accordingly, I carefully read through different data sources back and forth several times to familiarise myself with the raw data and looked for broad patterns relating to the research questions. When I scanned through the data, some 'ideas and identification of possible patterns' gradually emerged (Braun & Clarke, 2006, p. 87). In other words, when I paid attention to the data, I found some broad patterns in relation to students' MT use, such as MT for L2 reading and MT for L2 writing.

4.4.2 Coding data

The second step was to code the data into specific categories based on the broad patterns developed. Coding is to discover the meanings of the segments of data. Saldaña (2011) explains, 'codes function as a way of patterning, classifying, and later reorganizing each datum into emergent categories for further analysis' (p. 95). Among several different types of coding methods, descriptive coding is especially helpful when multiple types of data (e.g., interview transcripts, observation notes, and videos) are collected for one single study (Saldaña, 2011). Descriptive coding involves summarising the main topic of excerpts of data using a noun or

short phrase, so descriptive codes 'not only help categorize but also index the data corpus' basic contents for further analytic work' (Saldaña, 2011, p. 104). As such, for each type of data I adopted descriptive coding to generate descriptive codes. However, as I went along with the coding processes, I wondered whether there were particular methods suitable for coding translation processes. Hence, I searched for more coding approaches and found process coding beneficial. Process coding is also known as 'action coding', which is to use gerunds (a verb form ending with -ing) to denote 'observable activities' or 'general conceptual action (e.g., struggling, negotiating)' (Saldaña, 2013, p. 96). Accordingly, I adopted process coding for data in relation to translation processes.

Following descriptive coding and process coding (first cycle coding), I moved on to pattern coding (second cycle coding) to classify codes into relevant categories. The purposes of pattern coding are to organise the data corpus and to give the organisation meaning (Saldaña, 2013). This second cycle coding involved reviewing, revising, and finalising categories by re-reading the data alongside each category. The first and second cycle coding in my research have similarity to some components of Braun and Clarke's (2012) thematic analysis approach, including generating codes, searching for potential themes, reviewing themes, and naming themes. What follows details how I applied the coding methods for data from questionnaires, screen recordings, and focus group/individual interviews. I also elaborate how I used rubrics to evaluate and score the data of translation samples from SG1.

4.4.2.1 Questionnaires

Pre- and post-intervention questionnaires were used for both SG1 and SG2. They comprised closed-ended questions in a five-point rating scale in both questionnaires, and open-ended questions in the post-survey. To code the rating scale data, I identified descriptive codes, such as translating words, translating sentences, and translating paragraphs. These codes were then clustered into a category, such as using MT for translating different language units. I combined the open-ended written responses in the post-intervention questionnaire with the focus group/individual interview transcripts to code and analyse together.

4.4.2.2 Screen recordings

Screen recordings were utilised to record students' translation processes in the pre- and post-intervention tasks for SG1, and to record students' demonstrations and tutorial discussions about their MT use for SG2. However, unlike screen recordings for SG2 that could be transcribed, screen recordings for SG1 were silent so there was no recording to be transcribed.

For this reason, I undertook process coding of whatever could be observed, and generated codes using gerunds, such as translating through HT, using MT to translate words, using dictionaries to double-check MT output, finishing HT, using MT to check what is read, identifying misinterpretation of source text meaning, and editing HT output. The codes sharing the same patterns and focuses were then grouped into single categories. For example, the following codes – finishing HT, using MT to check what is read, identifying misinterpretation of source text meaning, and editing HT output – were clustered into a category named using MT to check reading comprehension. This coding process helped me present the sequence of activities explicitly by means of flow charts (see Figure 4.8).

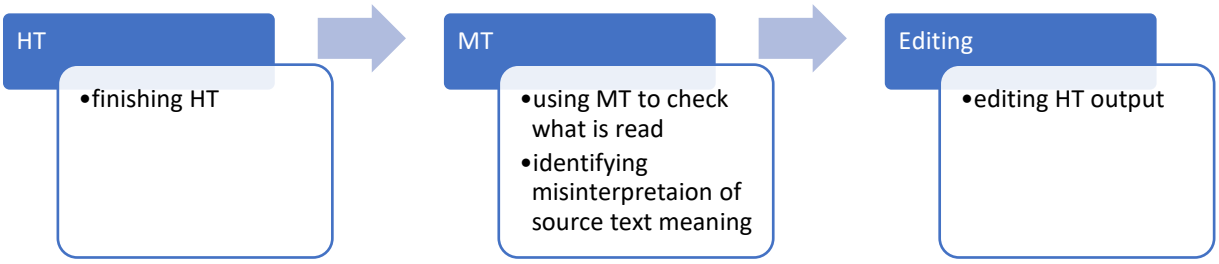


Figure 4.8 Example of using flow charts to present the sequence of activities

Similarly, process coding followed by pattern coding was applied to analyse the data of recording transcripts from SG2. Flow charts were used to present students' sequence or process of using MT and PE. As Saldaña (2013) puts it:

> …sequences or processes can be ordered as a numeric series of actions, listed as a bullet-pointed set of outcomes, or graphically represented with first-draft illustrations as a flow diagram (p. 98).

In addition to process coding, I also made descriptive codes for screenshots from screen recordings and used the screenshot images in combination with commentaries to present students' translation processes for both student groups. Descriptive codes summarising the topic of the data made it efficient to look for specific screenshots needed.

4.4.2.3 Focus group and individual interviews

Focus group interviews were adopted for both SG1 and SG2 to further understand student participants' experiences of and views about MT and PE. The open-ended questions in the post-intervention questionnaires were also used to learn more about their opinions of MT and PE. Having a similar purpose, both spoken and written responses were coded and analysed together. To manage considerable textual data, I coloured, highlighted, and underlined these data to generate descriptive codes when reading through the texts, followed by classifying

codes into different categories. Prior to finalising categories, I reviewed and revised the initial categories by re-reading the whole body of textual data along with each category. I merged and deleted categories until final categories were decided, such as using MT as a dictionary and using MT as a checking tool. Table 4.9 shows examples of categories generated from questionnaires, screen recordings, and focus group interviews from SG1.

Table 4.9 Examples of categories that emerged from different SG1 datasets

Questionnaires	- using MT for translating different language units - using MT for reading
Screen recordings	- using MT to translate different language units - using MT to check reading comprehension
Focus group interviews	- using MT as a dictionary - using MT as a checking tool

4.4.2.4 Translation samples

Translation samples from the pre- and post-intervention tasks for SG1 were collected in order to assess students' translation work made before and after the intervention. Angelelli's (2009) five-point-scale rubric for assessing translation quality is based on the theories of translation studies and SLA (see Appendix 4.7 for the rubric). Her rubric, hence, was considered to be appropriate for making a holistic marking of the students' translations in an L2 translation course. The rubric consists of five main categories: 1) source text meaning (source text comprehension); 2) style and cohesion (textual competence); 3) situational appropriateness (pragmatic competence); 4) grammar and mechanics (linguistic competence); and 5) translation skill (strategic competence). The element of style and cohesion refers to the ability to create a translated text in terms of text genre or type and to make the text coherent and cohesive. Situational appropriateness means the ability to use language appropriately in terms of discourse and register, including phrasing and word choice, while translation skill means the ability to use resources to overcome translation problems. Under each category, there are five-point-scale criteria and descriptors for assessing translation quality.

In addition, moderation practices, including peer scrutiny, double marking, and consensus moderation discussion, were applied in the process of translation assessment to reach agreement on marks awarded (Bloxham et al., 2016). According to Bloxham and colleagues, the purpose of double marking is to ensure fairness in grading decisions and consistency in marking standards. Double marking can be an approach to increase reliability of grading processes (Vidal Rodeiro, 2007). Thus, I employed double marking as an approach to ensure

fairness and consistency in assessing students' translation to generate reliable scoring data. Apart from me as an assessor, a second evaluator[14] was invited to assess translation samples using the same rubric. In advance of marking separately, I held a two-hour meeting for a pilot assessment with the second assessor to ensure that we both had a common understanding of the criteria in the rubric, and that we marked in a consistent way. More importantly, a moderation discussion through critical reflection on marking took place to negotiate discrepancies between us and to achieve an agreement on final grades. An average score was used for a few marks that did not reach an agreement after negotiation (Bloxham et al., 2016; Vidal Rodeiro, 2007). The scoring data were used to understand whether students' translations improved across the five categories before and after the intervention.

4.4.3 Comparing data

According to Burns (2009), the third step in data coding is to compare categories across different datasets and to see if there are contradictions. However, I aimed to gain a comprehensive understanding of this study from different dimensions rather than simply to compare data. Consequently, I focused on the integration of diverse data sources for an integrated analysis (Moran-Ellis et al., 2006). After identifying categories from each dataset, I analysed them as a whole to address common research questions. Specifically, I adopted Moran-Ellis et al.'s (2006) approach of 'following a thread' to undertake an integrated analysis, namely, picking a 'theme in one dataset and follow[ing] it across the others (the thread) to create a constellation of findings' (p. 54). For example, I used the category 'MT for reading' in the questionnaire data and followed this category across screen recording and focus group interview data to generate relevant findings. Figure 4.9 shows an example of using Moran-Ellis and colleagues' integrated analysis to create findings. This iterative analytic process helped me to 'interweave the findings that emerge from each dataset' (Moran-Ellis et al., 2006, p. 54). This approach resembles what Saldaña (2013, p. 248) has called 'codeweaving' after the first and second cycle coding to 'interpret how the individual components of the study weave together…to see how the puzzle pieces fit together'.

[14] The expertise of the second assessor, Dr Xuan Li, includes qualifications in Chinese-English translation, and a PhD in translanguaging in bi-/multilingual education, particularly in the Chinese-English bilingual context.

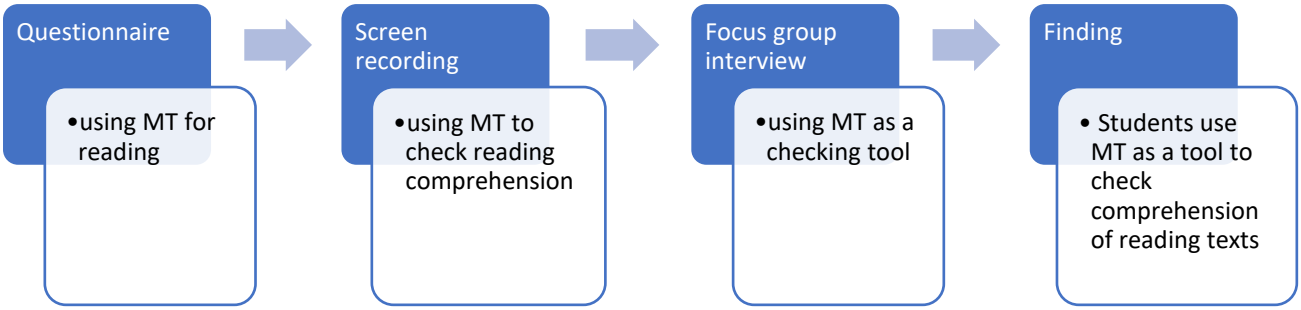


Figure 4.9 Example of using Moran-Ellis et al.'s (2006) integrated analysis to generate findings

In summary, the processes of first and second cycle coding and integrated analysis of various datasets enabled me to gain a multifaceted picture of the study through triangulation between the 'macro-level' measures (i.e., rating scale data from questionnaires and scoring data from translation samples) and 'micro-level' measures (i.e., screen recording and focus group interview data). Adopting qualitative information on students' translation processes and their experiences and opinions of using MT and PE (micro-level measures) in combination with numerical data to compare changes in their MT use and translation quality (macro-level measures) provided me with a fuller understanding of the data. Numerical data were used to support and amplify the qualitative data. It needs to be noted that email correspondence of follow-up enquiries was used only to clarify unexpected findings as they were collected after the completion of the integrated data analysis. Nonetheless, the follow-up enquiry data were important and accounted for an essential part of reflexive practice and analysis for this action research. Findings from both student groups are presented in Chapters 5 and 6 respectively.

4.4.4 Building meanings and interpretations

The aim of the fourth step of data analysis was to build meanings and interpretations of the study by thinking in depth about the meaning beyond the data. Burns (2009, p. 105) recommends the researcher to 'identify connections, and develop explanations about what the research means at the broadest level'. With this in mind and reflecting on the implications of research findings beyond the data, I carried out a meta-analysis to interpret and discuss the findings from the two student groups through different lenses. To this end, I examined whether students' use of MT and PE (human-machine interaction) can advance language learning through interactionist SLA theory (e.g., Gass & Mackey, 2014; Long, 1996). I then used Nida's (1969) three-phase model of the translation process in translation studies to further analyse students' translation processes. The rationale for adopting Nida's model was that the model was applicable not only to professional translation teaching but also to general translation

teaching (Kim, 2015). Analyses of students' use of MT and PE in their translation processes helped me understand the role and function of MT and PE in language learning. Last, I considered findings through the perspective of translanguaging (e.g., Baker & Wright, 2021; Heugh, 2021), which provided a big picture of how multilingual capability and knowledge acquisition could be enhanced through human-machine interaction in multilingual learning and teaching. The analysis of research findings through the three lenses enabled me to understand the potential of MT and PE, which is discussed in detail in Chapter 7.

4.5 Ethical consideration

Prior to commencing this action research, I sought ethics approval from the UniSA Human Research Ethics Committee (HREC) as a prerequisite for data collection. Approval was accomplished with guidance from the relevant academic staff at UniSA. Participant consent forms, the processes for participant confidentiality and anonymity, and the methods of data collection and management were all included in the ethics application. This research was subsequently undertaken in accordance with UniSA ethics protocols. All collected data in relation to each participant were labelled by a new identifier.

In teacher-student research, students might provide unclear or ambiguous responses to the inquiries of teachers as they might be afraid that truthful answers would have negative consequences for them. Students might also feel compelled to participate in the research processes even when they have been informed and signed consent forms that permit their withdrawal without consequence. This action research study, however, avoided these issues. For SG1, the translation course was an independent pilot program designed for this research where participants were invited on a voluntary basis by my colleagues working at NTU. For SG2, the MT and PE teaching was also a pilot collaborative tutoring process planned for the study, in which the recruited students at UniSA were voluntary participants. The performance and opinions of participants in this study does not in any way affect student grades or status at either university. These considerations support data reliability.

4.6 Chapter summary

A summary of this action research design and procedure is shown in Figure 4.10 (expanded version of Figure 4.2) indicating the five-phase action research procedure used with Student Group 1 (SG1) and Student Group 2 (SG2) in their different settings. A triangulation of multiple data sources and two cycles of data coding followed by an integrated data analysis helped me to gain a comprehensive understanding of the data. The findings from SG1

influenced the intervention for SG2, as modifications to the planned tutoring intervention for SG2 were made as a result of reflexive analysis of SG1 findings. Moreover, the meta-analysis of the findings of both groups through different lenses and the ongoing reflection and reflexivity allowed me to offer recommendations for future teaching practice and research. This is illustrated in the concluding chapter (Chapter 8).

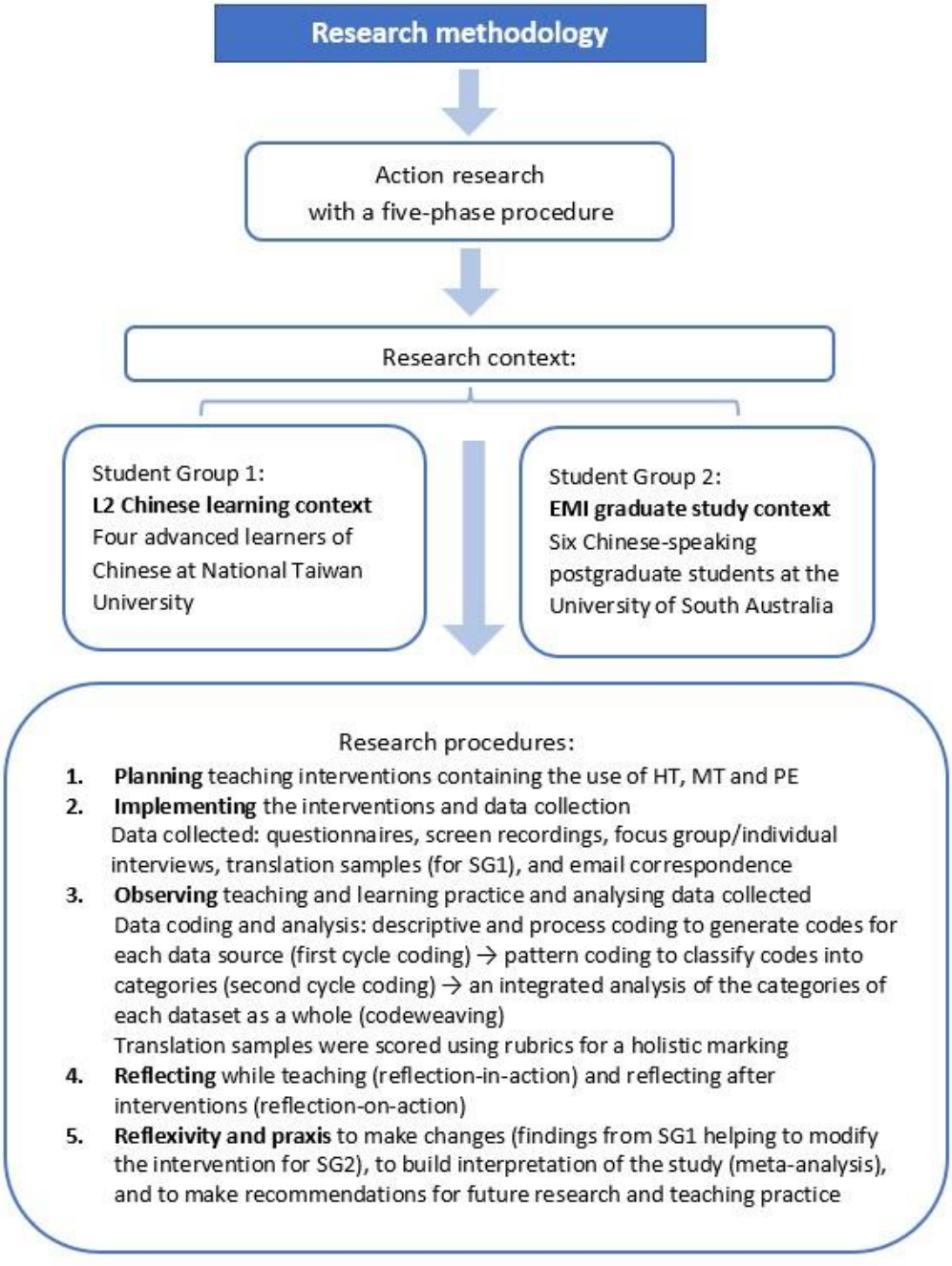


Figure 4.10 Summary of this action research design and procedure

Note on Reporting Convention: In Chapters 5, 6 & 7, I use the present tense when showing student translation processes as they unfold inside the tables. I also use present tense when

discussing students' habitual or ongoing practices as disclosed in open-ended questionnaire and focus group interview data. I use past tense when discussing student reporting of a one-off task, and when I offer an interpretation of the screenshot data immediately before or after each of the tables and figures that relate to screenshot data.

5 Advanced learners of Chinese using MT and PE in an L2 Chinese learning context: Findings[15]

This chapter presents data, findings, and preliminary analysis from Student Group 1 (SG1), comprising Rory, Lisa, Maggie and Amanda. As indicated in Chapter 4, triangulation of multiple research data has been used to gain complementary insights and broad understanding of the potential of MT and PE to advance L2 learning. Integrated analysis of multiple datasets has been used to generate related findings in relation to each research question (RQ).

RQ1 (How do multilingual learners use MT to support their L2 learning?) is addressed by analysing data from screen recordings of pre- and post-intervention tasks, focus group interviews, and pre- and post-intervention questionnaires. Findings in relation to RQ1 are presented in Section 5.1. First, I summarise the observations of screen recording data, showing how students use MT in the completion of translations in the pre- and post-intervention tasks in Section 5.1.1. This is to outline students' translation processes and strategies for translating texts before and after the intervention. Then, five purposeful uses of MT and related strategies generated from multiple data sources in relation to how students use MT are presented in Section 5.1.2. This is to further understand how they use MT in the L2 Chinese learning context more widely. Analyses in Section 5.1.3 of how the students use MT suggest the nature of capabilities that are involved in MT and PE.

RQ2 (Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?) is addressed through data obtained from: scoring students' translation samples for the pre- and post-intervention tasks, focus group interviews, questionnaires, and follow-up email correspondence. Section 5.2 presents RQ2 findings. Five interrelated processes generated from the data are discussed to shed light on the contribution of MT and PE capabilities to advance L2 Chinese learning. Section 5.3 includes teacher-researcher reflection after the intervention. The chapter concludes with a summary in Section 5.4.

[15] As indicated earlier, the sample size of 15 participants was reduced to four owing to COVID-19. The findings discussed here are recognised as indicative and would benefit from a larger follow-up study.

5.1 Students' use of MT in L2 Chinese learning

I present and discuss how the L2 Chinese students use MT to help with Chinese language learning below. Section 5.1.1 focuses on students' translation processes and strategies for using MT. Section 5.1.2 focuses on students' purposeful use of MT to support Chinese language learning.

5.1.1 Students' translation processes and strategies

I used screen-recordings of students working on translations in the pre- and post-intervention tasks to understand students' translation processes and strategies to complete translations. As indicated in Chapter 4, the tasks included two Chinese to English translations and two English to Chinese translations. The translation materials comprised two Chinese texts – Text 1 (magazine) and Text 2 (idiomatic story), and two English texts – Text 3 (biography) and Text 4 (short novel). Each text was a paragraph in length, approximately 100 words.

Screen recording data show that each of the four students had their own specific translation behaviours. Three students (Rory, Lisa and Maggie) used human translation (HT) to complete the four text translations in the pre-intervention task, while they changed their approach to adopt MT+PE to varying degrees in order to complete translations in the post-intervention task. One student (Amanda) mostly used MT+PE to finish translations in both pre- and post-intervention tasks. To present each of the four students' translation processes of HT and MT+PE, I selected one of their translations through HT in the pre-intervention task and one of their translations through MT+PE in the post-intervention task. It needs to be noted that when students used their smartphone dictionary app such as Pleco[16] in translation, it could not be recorded on the screen. Nevertheless, even though I could not see students' use of this app on their phones, I observed some pauses on the screen. When asked about the pauses after the tasks, the four students confirmed using Pleco at those times.

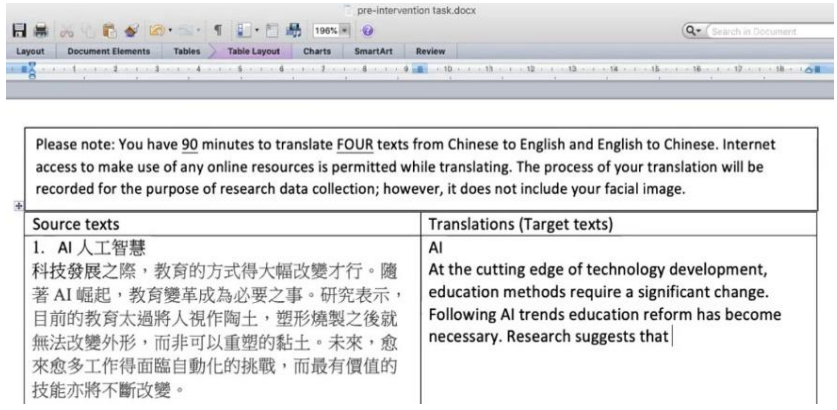
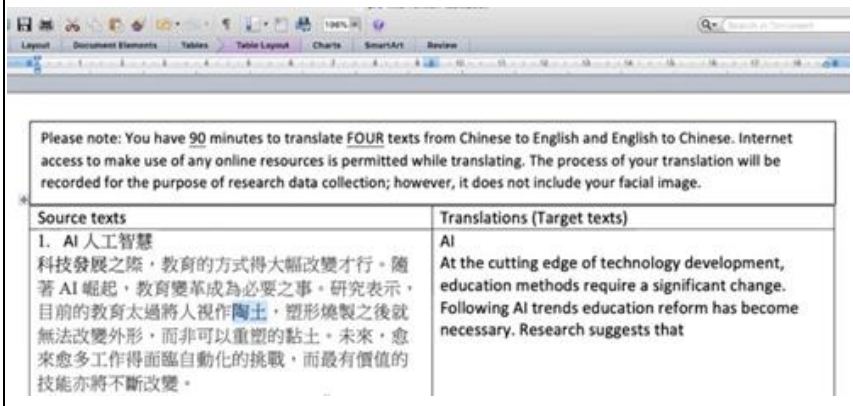
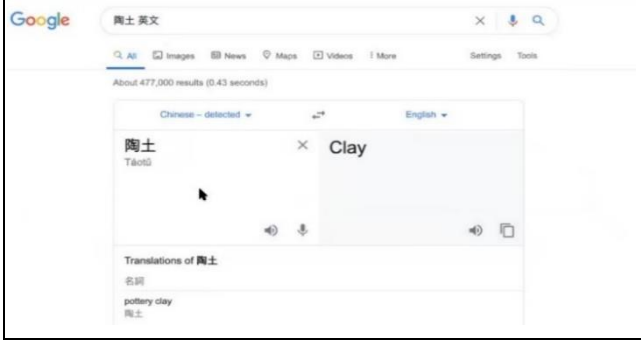
5.1.1.1 Rory – L1 English speaker and L2 Chinese learner at a C1 level

In the pre-intervention task, Rory used HT to engage in translation while adopting MT (Google Translate) to look up words and phrases for the four texts. When he consulted Google Translate for words/phrases, he used additional resources including Pleco and the Google search engine to double-check the accuracy of MT word/phrase output. After Rory completed an entire text

[16] Pleco is a dictionary app that is commonly used by learners of Chinese.

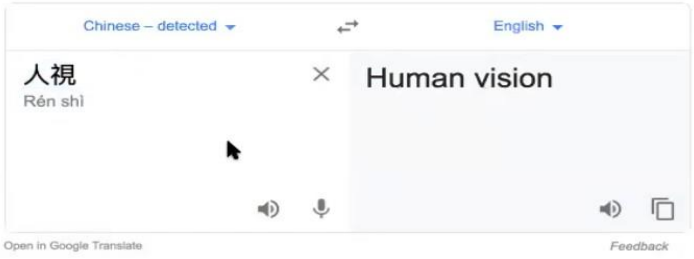
translation through HT, he employed MT output to check and compare his own HT output to help with revisions. Table 5.1 presents the screenshots of Rory's HT process with Text 1 (Chinese to English translation) in the pre-intervention task. This is accompanied by a researcher commentary based on close observation of each screen recording; the highlighting in the screenshots indicates the particular items attended to by the student at the time and referred to in the commentary.

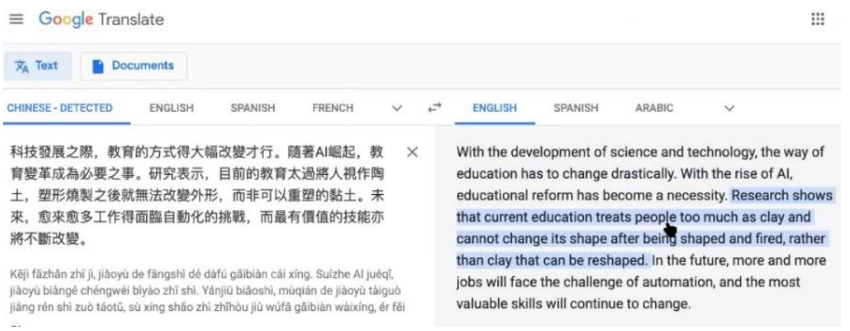
Table 5.1 Screenshots of Rory's HT process with Text 1 in the pre-intervention task

Screenshots	Commentary
	1. Rory translates this text through HT easily to this point.
	2. He is stuck on this word '陶土(clay)'.
	3. He looks up the meaning using MT (Google Translate).

<table>
<tr>
<td>
</td>
<td>4.
He looks for translations of these characters in MT.

(Rory runs into a Chinese word segmentation[17] problem. The characters he splits are not meaningful language units. The correct segmentation is: jiang/ren/shizuo/taotu, but Rory appears to segment this phrase as: jiang/renshi/zuo/taotu.)</td>
</tr>
<tr>
<td><table>
<tr><th>Source texts</th><th>Translations (Target texts)</th></tr>
<tr><td>1. AI 人工智慧
科技發展之際，教育的方式得大幅改變才行。隨著 AI 崛起，教育變革成為必要之事。研究表示，目前的教育太過將人視作陶土，塑形燒製之後就無法改變外形，而非可以重塑的黏土。未來，愈來愈多工作得面臨自動化的挑戰，而最有價值的技能亦將不斷改變。
Adapt from The Economist:
https://www.cw.com.tw/article/article.action?id=5082553</td><td>AI
At the cutting edge of technology development, education methods require a significant change. Following AI trends education reform has become necessary. Research suggests that today overly relies on human sight as clay, after the form is fired there's no way to change the shape. In future, more and more work has to face the challenge of automation, and so the most valuable skills will continue changing.</td></tr>
</table></td>
<td>5.
He translates these characters into ‘human sight as clay’.

(Rory may be not happy with this translation after finishing the translation for this text.)</td>
</tr>
<tr>
<td>
</td>
<td>6.
He looks up the meaning for these two characters in MT.

(This shows a continued word segmenting problem.)</td>
</tr>
<tr>
<td>
</td>
<td>7.
Finally, he consults MT for a whole paragraph translation.

(Rory appears to find his incorrect segmenting and seems to recognise the phrase jiang/ren/shizuo means ‘treating people as’)</td>
</tr>
</table>

[17] Chinese word segmentation is to split a string of Chinese characters in a sentence into meaningful language units such as words and phrases. Chinese words/phrases can be comprised of several Chinese characters; therefore, the ability to split characters is a fundamental step in understanding a text in Chinese.

Source texts	Translations (Target texts)	
1. AI 人工智慧 科技發展之際，教育的方式得大幅改變才行。隨著 AI 崛起，教育變革成為必要之事。研究表示，目前的教育太過將人視作陶土，塑形燒製之後就無法改變外形，而非可以重塑的黏土。未來，愈來愈多工作得面臨自動化的挑戰，而最有價值的技能亦將不斷改變。 Adapt from The Economist: https://www.cw.com.tw/article/article.action?id=5082553	AI With developments in science and technology, education methods must also undergo significant change. Trends in AI have made education reform a necessity. Research shows that today's education treats people too much like clay, with no way to change their initial form after it has been hardened, unable to be re-molded into a new shape. Yet in future, as more and more work faces the challenge of automation, the most valuable skills will continually change.	8. He revises and finalises his translation through HT.

The screenshots of this Chinese to English translation in the pre-intervention task show that even though Rory adopted MT (Google Translate) to look up meanings for words and phrases, he mistranslated the meaning of the source sentence because of word segmenting problems. The misinterpreting problem was only resolved when Rory referred to a whole paragraph translation by MT. This subsequently helped him revise his own translation generated by HT. This example indicates that using MT to translate larger language units (e.g., sentences and paragraphs) may help to avoid mistranslation resulting from incorrect word segmentation. This also suggests that the ability to segment Chinese characters plays an important role in L2 Chinese reading and Chinese to English translation. Figure 5.1 shows Rory's HT process in the pre-intervention task.

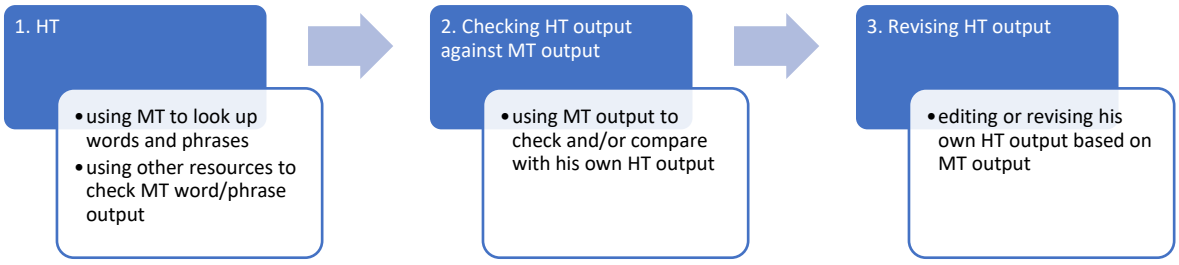
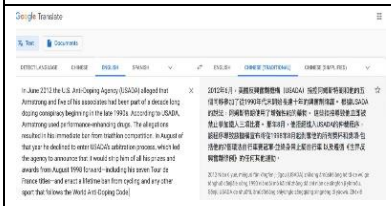
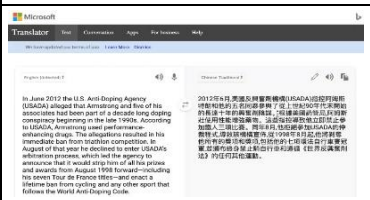
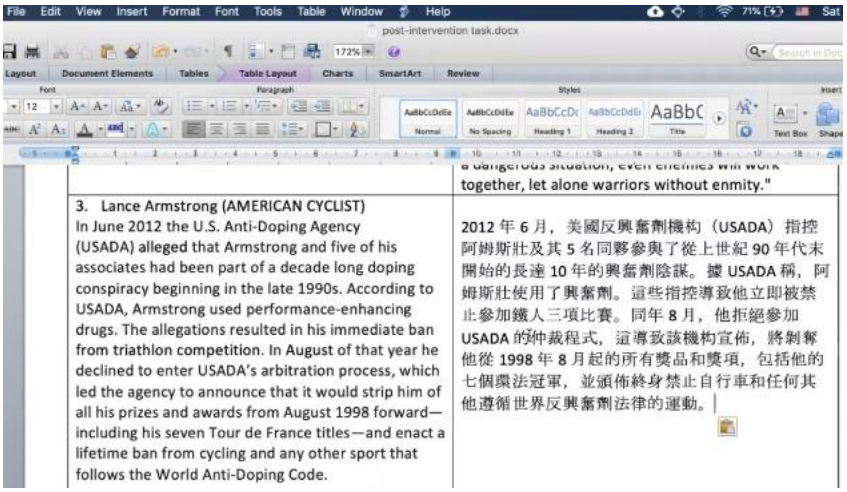
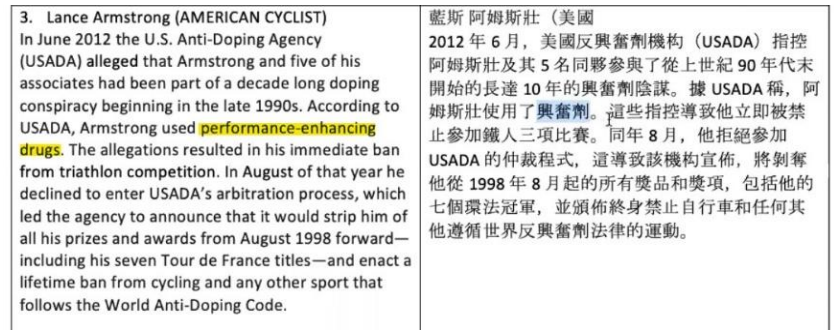
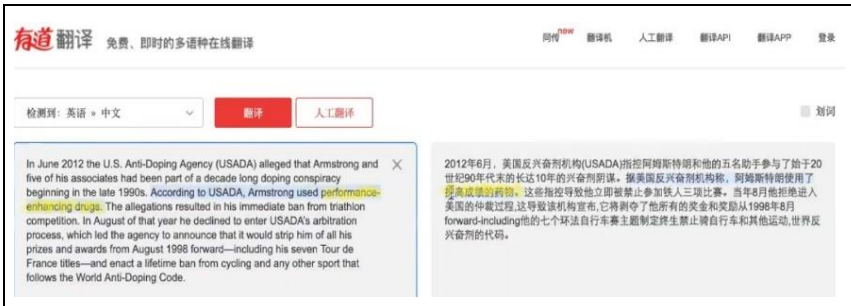
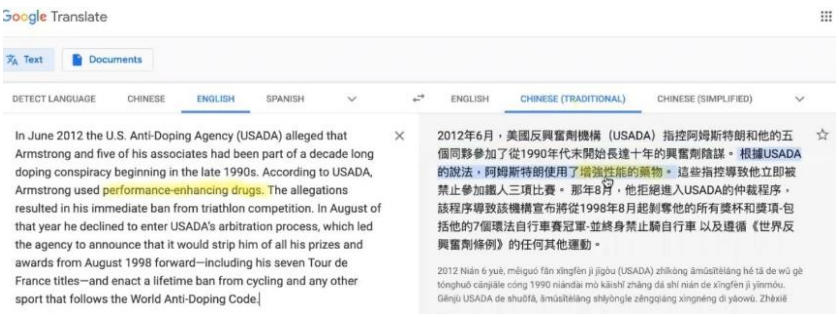
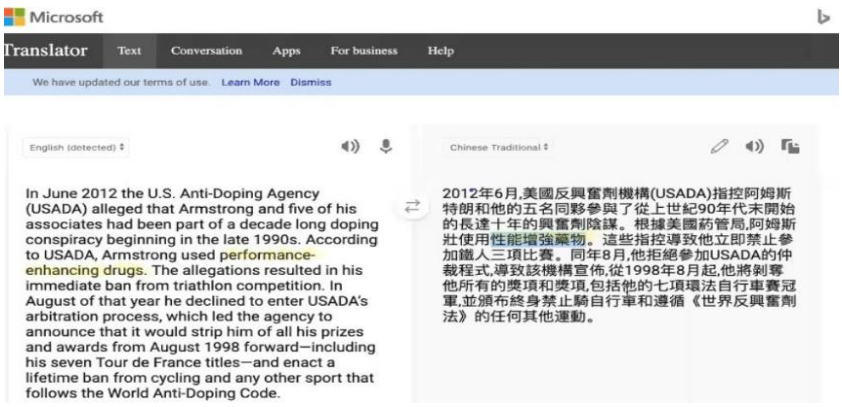
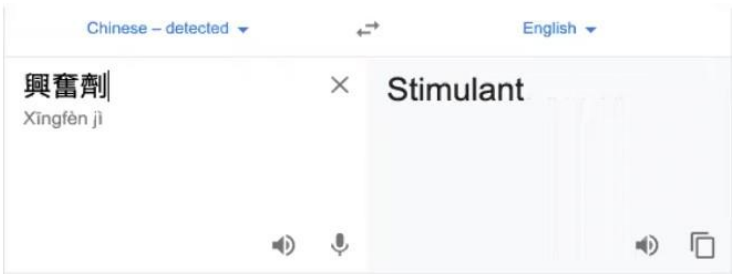


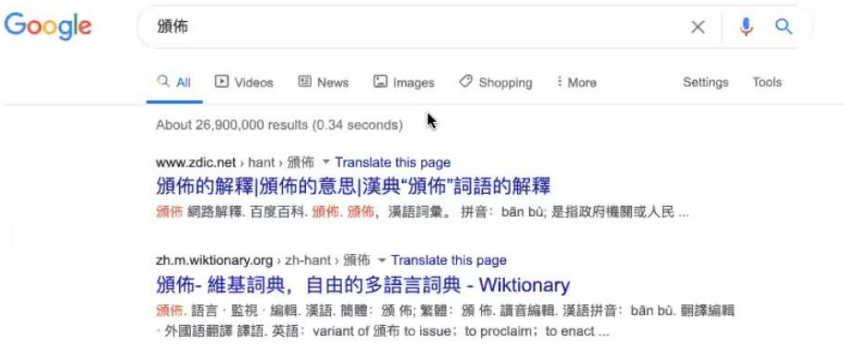
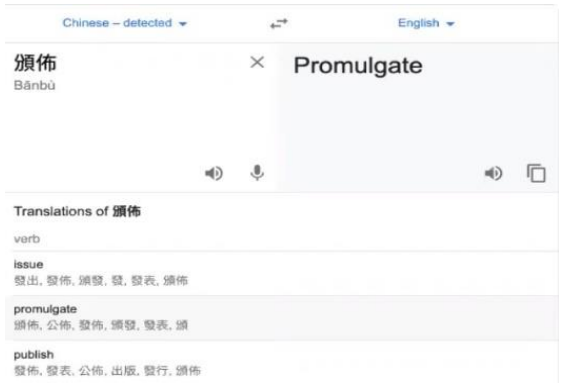
Figure 5.1 Rory's HT process in the pre-intervention task

In the post-intervention task, Rory adopted MT followed by PE (MT+PE) to complete the four text translations. Table 5.2 presents the screenshots of Rory's MT+PE process with Text 3 (English to Chinese translation) in the post-intervention task.

Table 5.2 Screenshots of Rory's MT+PE process with Text 3 in the post-intervention task

<table>
<tr><th colspan="2">Screenshots</th><th>Commentary</th></tr>
<tr><td>
A</td><td>
B</td><td rowspan="2">1.
Rory obtains different paragraph translations in Chinese from four MT tools:
A) Baidu
B) Youdao
C) Google
D) Microsoft</td></tr>
<tr><td>
C</td><td>
D</td></tr>
<tr><td colspan="2">
3. Lance Armstrong (AMERICAN CYCLIST)
In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decade long doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code.
together, let alone warriors without enmity."
2012 年 6 月，美國反興奮劑機构（USADA）指控阿姆斯壯及其 5 名同夥參與了從上世紀 90 年代末開始的長達 10 年的興奮劑陰謀。據 USADA 稱，阿姆斯壯使用了興奮劑。這些指控導致他立即被禁止參加鐵人三項比賽。同年 8 月，他拒絕參加 USADA 的仲裁程式，這導致該機构宣佈，將剝奪他從 1998 年 8 月起的所有獎品和獎項，包括他的七個環法冠軍，並頒佈終身禁止自行車和任何其他遵循世界反興奮劑法律的運動。</td><td rowspan="2">2.
He chooses Baidu output as a draft for undertaking PE.</td></tr>
<tr><td colspan="2">
3. Lance Armstrong (AMERICAN CYCLIST)
In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decade long doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code.
藍斯 阿姆斯壯（美國
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He reads the Baidu text and then gets stuck on the Chinese translation of the term 'performance-enhancing drugs'.</td></tr>
</table>

	4. He looks at the translation of the term 'performance-enhancing drugs' from Youdao. The Youdao Chinese translation is '提高成绩的药物'.
	5. He looks at this translation from Google Translate.
	6. He looks at this translation from Microsoft.
	7. He uses Google Translate to look up the meaning of this Baidu output.

3. Lance Armstrong (AMERICAN CYCLIST) In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decade long doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code. 藍斯 阿姆斯壯（美國 2012 年 6 月，美國反興奮劑機构（USADA）指控阿姆斯壯及其 5 名同夥參與了從上世紀 90 年代末開始的長達 10 年的興奮劑陰謀。據 USADA 稱，阿姆斯壯使用了性能增強藥物。這些指控導致他立即被禁止參加鐵人三項比賽。同年8 月，他拒絕參加 USADA 的仲裁程式，這導致該機构宣佈，將剝奪他從 1998 年 8 月起的所有獎品和獎項，包括他的七個環法冠軍，並頒佈終身禁止自行車和任何其他遵循世界反興奮劑法律的運動。	8. He changes the Baidu output '興奮劑' to this term '性能增強藥物' from Microsoft.
3. Lance Armstrong (AMERICAN CYCLIST) In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decade long doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code. 藍斯 阿姆斯壯（美國 2012 年 6 月，美國反興奮劑機构（USADA）指控阿姆斯壯及其 5 名同夥參與了從上世紀 90 年代末開始的長達 10 年的興奮劑陰謀。據 USADA 稱，阿姆斯壯使用了性能增強藥物。這些指控導致他立即被禁止參加鐵人三項比賽。同年 8 月，他拒絕參加 USADA 的仲裁程序，這導致該機构宣佈，將剝奪他從 1998 年 8 月起的所有獎品和獎項，包括他的七個環法冠軍，並頒佈終身禁止自行車和任何其他遵循世界反興奮劑法律的運動。	9. He is not sure about the Chinese translation of the word 'announce'.
	10. He looks up the meaning of this Chinese word using Google search engine. (He does not appear to find an answer.)
	11. He adopts Google Translate to look up the meaning of this Chinese word.

3. Lance Armstrong (AMERICAN CYCLIST) In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decade long doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code. 藍斯 阿姆斯壯（美國自行車手） 2012 年 6 月，美國反興奮劑機构（USADA）指控阿姆斯壯及其 5 名同夥參與了從上世紀 90 年代末開始的長達 10 年的興奮劑陰謀。據 USADA 稱，阿姆斯壯使用了性能增強藥物。這些指控導致他立即被禁止參加鐵人三項比賽。同年 8 月，他拒絕參加 USADA 的仲裁程序，這導致該機构宣佈，將剝奪他從 1998 年 8 月起的所有獎品和獎項，包括他的七個環法冠軍，並頒佈終身禁止自行車和任何其他遵循世界反興奮劑法律的運動。	12. He keeps the translation of Baidu for this word and finishes post-editing the Baidu text. (He appears to believe this highlighted word to be correct, but it is unsuitable here in terms of word usage.)
3. Lance Armstrong (AMERICAN CYCLIST) In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decade long doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code. Source from Encyclopaedia https://www.britannica.com/biography/Lance-Armstrong 藍斯 阿姆斯壯（美國自行車手） 2012 年 6 月，美國反興奮劑機构（USADA）指控阿姆斯壯及其 5 名同夥參與了從上世紀 90 年代末開始的長達 10 年的興奮劑陰謀。據 USADA 稱，阿姆斯壯使用了性能增強藥物。這些指控導致他立即被禁止參加鐵人三項比賽。同年 8 月，他拒絕參加 USADA 的仲裁程序，這導致該機构宣佈，將剝奪他從 1998 年 8 月起的所有獎品和獎項，包括他的七個環法冠軍，並頒佈終身禁止自行車和任何其他遵循世界反興奮劑法律的運動。 2012 年 6 月，美国反兴奋剂机构(USADA)指控阿姆斯特朗和他的五名助手参与了始于 20 世纪 90 年代末的长达 10 年的兴奋剂阴谋。据美国反兴奋剂机构称，阿姆斯特朗使用了提高成绩的药物。这些指控导致他立即被禁止参加铁人三项比赛。当年 8 月他拒绝进入美国的仲裁过程,这导致该机构宣布,它将剥夺了他所有的奖金和奖励从 1998 年 8 月 forward-including 他的七个环法自行车赛主题制定终生禁止骑自行车和其他运动,世界反兴奋剂的代码。	13. He checks his Chinese translation generated by MT+PE against the Youdao output. He finds different translations for this word 'associates'.
Chinese – detected ⇄ English 同夥 × Associate Tónghuǒ Translations of 同夥 noun partner 伙伴, 夥伴, 伴侶, 搭檔, 同伴, 同夥	14. He uses Google Translate to double-check the meaning of this Chinese word.
3. Lance Armstrong (AMERICAN CYCLIST) In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decade long doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code. 藍斯 阿姆斯壯（美國自行車手） 2012 年 6 月，美國反興奮劑機构（USADA）指控阿姆斯壯及其 5 名同夥參與了從上世紀 90 年代末開始的長達 10 年的興奮劑陰謀。據 USADA 稱，阿姆斯壯使用了性能增強藥物。這些指控導致他立即被禁止參加鐵人三項比賽。同年 8 月，他拒絕參加USADA 的仲裁程序，這導致該機构宣佈，將剝奪他從 1998 年 8 月起的所有獎品和獎項，包括他的七個環法冠軍，並頒佈終身禁止自行車和任何其他遵循世界反興奮劑法律的運動。	15. He ends up keeping this translation made by MT+PE without making any changes after comparing with Youdao output. (He appears to find that his translation is more accurate than that of Youdao.)

It is apparent from Table 5.2 that Rory's MT+PE process in the English to Chinese translation consisted of four steps. First, he used four MT tools (Baidu, Youdao, Google, and Microsoft) to obtain four versions of MT output and subsequently made a judgment about which of the four appeared to produce the best version to serve as a draft for undertaking PE. Second, he evaluated MT accuracy based on the source text. To do so, he referred to the other three MT texts and adopted Google Translate and other resources, such as the Google search engine, to cross-check MT word/phrase output. Third, he modified or edited the MT output. Fourth, he compared his translations made by MT+PE with another MT text to help with revisions. Figure 5.2 shows Rory's MT+PE process in the post-intervention task. Steps two and three are a repeated cycle for each language unit being translated, which may be at word, phrase, or sentence levels.

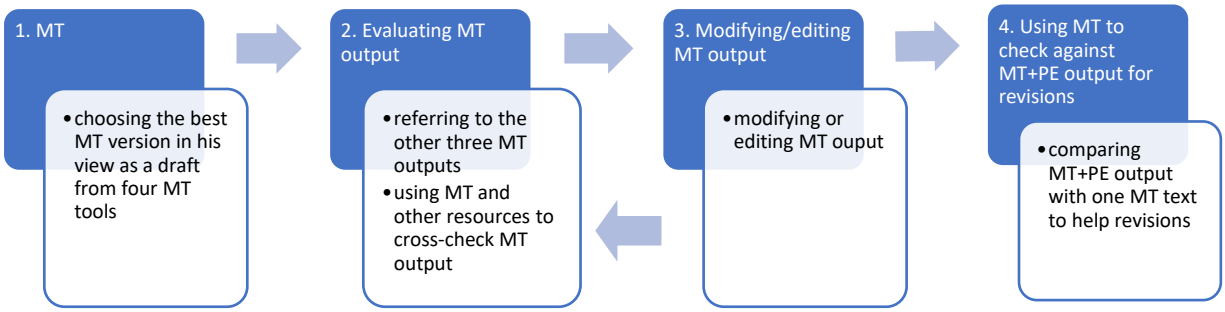


Figure 5.2 Rory's MT+PE process in the post-intervention task

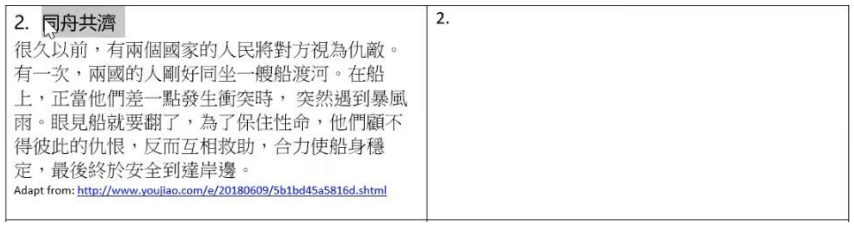
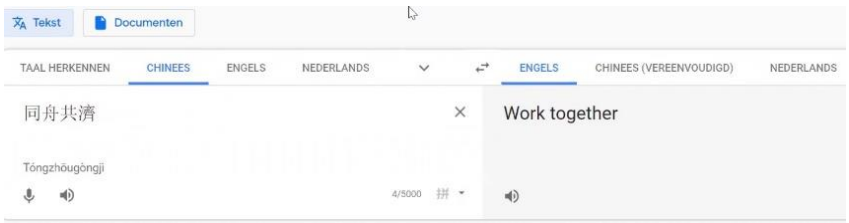
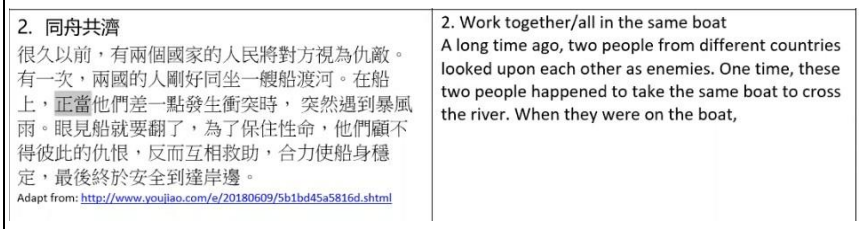
Comparing Rory's translation processes between the pre- and post-intervention tasks reveals that when Rory undertook HT, he used Google Translate to assist with word and phrase translations and to compare his own HT output followed by revisions. When engaging in MT+PE, he paid attention to evaluating MT accuracy. Rory employed multiple MT tools and additional resources to help judge MT accuracy and edit inappropriate MT output when needed. He continued using MT to check against the translation he had completed by MT+PE. This means when Rory is not confident with his translation, regardless of whether it is English or Chinese translation and whether it is through HT or MT+PE, he will compare his translation with MT text to assist revisions in order to increase the degree of translation accuracy.

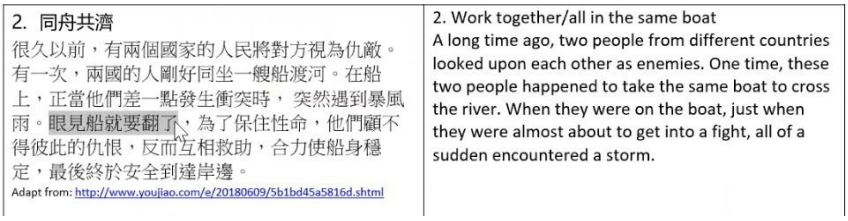
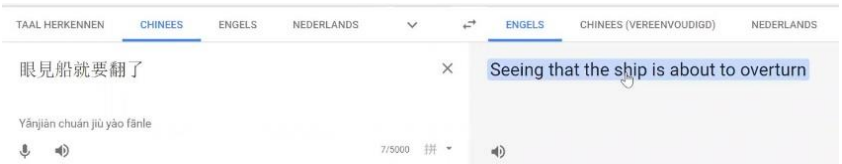
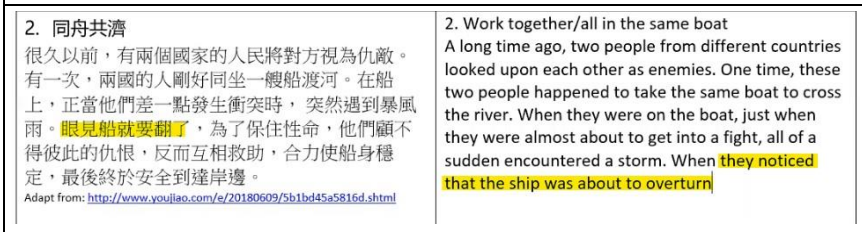
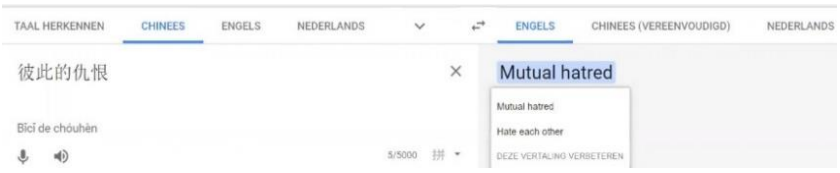
5.1.1.2 Lisa – L1 Dutch speaker and L2 Chinese learner at a B2 level

In the pre-intervention task, Lisa completed the four translations through HT with the use of MT (Google Translate) to look up words and phrases. However, she adopted MT+PE when encountering difficulties in HT. She used other resources such as Pleco, LINE Dict, and Google Search to double-check MT word/phrase output when using MT. After translation problems

were solved, Lisa returned to HT. Table 5.3 presents the screenshots of Lisa's HT process with Text 2 (Chinese to English translation) in the pre-intervention task.

Table 5.3 Screenshots of Lisa's HT process with Text 2 in the pre-intervention task

Screenshots	Commentary
	1. Lisa copies this idiomatic expression '同舟共濟(all in the same boat)'.
	2. She pastes this expression into MT (Google Translate).
	3. She looks up this word in the Line dictionary (LINE Dict) and reads the sample sentences.
	4. She translates this text through HT to this point and gets stuck on this word '正當(just when)'.

	5. She looks up the meaning in MT.
	6. She gets stuck on this sentence.
	7. She uses MT to translate the sentence.
	8. She edits the MT sentence output as marked in yellow. (This shows that Lisa performs MT+PE to make MT output more suitable in context.)
	9. She looks up the meaning of this phrase in LINE Dict.
	10. She adopts MT to look for the meaning of this phrase.

2. 同舟共濟 很久以前，有兩個國家的人民將對方視為仇敵。有一次，兩國的人剛好同坐一艘船渡河。在船上，正當他們差一點發生衝突時， 突然遇到暴風雨。眼見船就要翻了，為了保住性命，他們顧不得彼此的仇恨，反而互相救助，合力使船身穩定，最後終於安全到達岸邊。 Adapt from: http://www.youjiao.com/e/20180609/5b1bd45a5816d.shtml	2. Work together/all in the same boat A long time ago, two people from different countries looked upon each other as enemies. One time, these two people happened to take the same boat to cross the river. When they were on the boat, just when they were almost about to get into a fight, all of a sudden encountered a storm. When they noticed that the ship was about to overturn, in order to protect their lives, they put aside/neglected/forgot about their mutual hatred	11. She translates this sentence following the use of LINE Dict and MT.
2. 同舟共濟 很久以前，有兩個國家的人民將對方視為仇敵。有一次，兩國的人剛好同坐一艘船渡河。在船上，正當他們差一點發生衝突時， 突然遇到暴風雨。眼見船就要翻了，為了保住性命，他們顧不得彼此的仇恨，反而互相救助，合力使船身穩定，最後終於安全到達岸邊。 Adapt from: http://www.youjiao.com/e/20180609/5b1bd45a5816d.shtml	2. Work together/all in the same boat A long time ago, two people from different countries looked upon each other as enemies. One time, these two people happened to take the same boat to cross the river. When they were on the boat, just when they were almost about to get into a fight, all of a sudden encountered a storm. When they noticed that the ship was about to overturn, in order to protect their lives, they put aside/neglected/forgot about their mutual hatred, and even saved each other. They pool efforts/joined forces/work together to stabilize the hull of the ship. In the end they reached the shore safely.	12. She finishes her translation. (Lisa's usual process is to write down any possible translations with slashes and return to edit the texts after she finishes the four text translations.)
2. 同舟共濟 很久以前，有兩個國家的人民將對方視為仇敵。有一次，兩國的人剛好同坐一艘船渡河。在船上，正當他們差一點發生衝突時， 突然遇到暴風雨。眼見船就要翻了，為了保住性命，他們顧不得彼此的仇恨，反而互相救助，合力使船身穩定，最後終於安全到達岸邊。 Adapt from: http://www.youjiao.com/e/20180609/5b1bd45a5816d.shtml	2. We're all in the same boat A long time ago, two people from different countries looked upon each other as enemies. One time, these two people happened to take the same boat to cross the river. When they were on the boat, just when they were almost about to get into a fight, they all of a sudden encountered a storm. When they noticed that the ship was about to overturn, they disregarded their mutual hatred in order to protect their lives, and even saved each other. They joined forces to stabilize the hull of the ship. In the end they reached the shore safely.	13. She edits and finalises her translation. (The changes she makes are marked in yellow.)

As evidenced in Table 5.3, Lisa adopted MT together with dictionaries to assist with the meaning of words, phrases, and idiomatic expressions. Specifically, she used dictionaries to check the accuracy of MT output. When having difficulties in HT she also employed MT to translate sentences followed by post-editing of the MT sentence output (MT+PE). When the translation problem was solved, Lisa returned to HT. Figure 5.3 shows Lisa's HT process in the pre-intervention task.

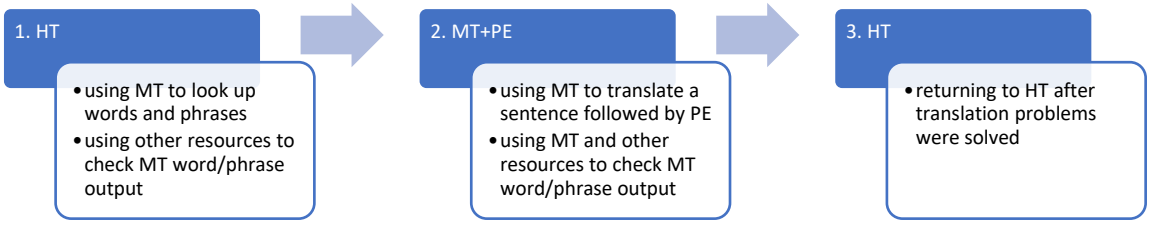
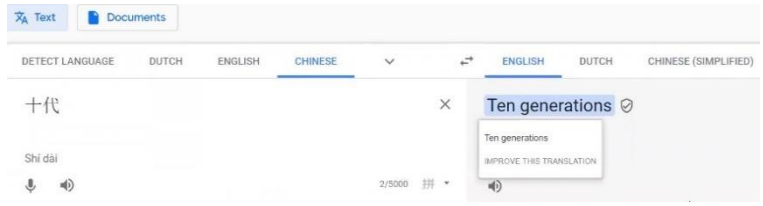


Figure 5.3 Lisa's HT process in the pre-intervention task

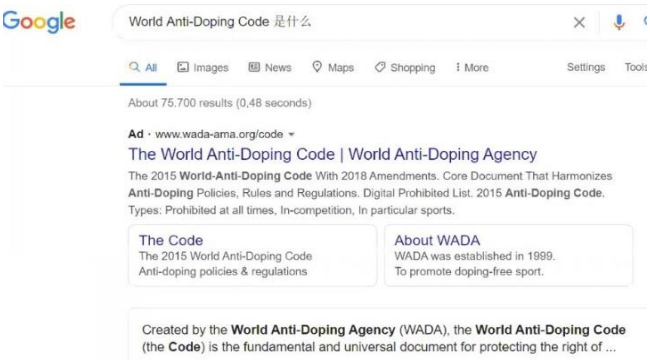
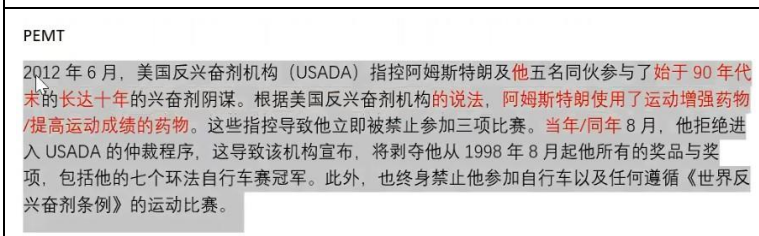
In the post-intervention task, Lisa continued using HT to complete the translation of Text 2. However, she adopted multiple MT tools (Google, Baidu, and Youdao) to translate Texts 1, 3, and 4. Table 5.4 presents the screenshots of Lisa's MT+PE process with Text 3 (English to Chinese translation) in the post-intervention task.

Table 5.4 Screenshots of Lisa's MT+PE process with Text 3 in the post-intervention task

Screenshots	Commentary
 A  B  C	1. Lisa obtains three different paragraph translations in Chinese from three MT tools: A) Google B) Baidu C) Youdao
In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decadelong doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code. google 2012 年 6 月，美国反兴奋剂机构（USADA）指控阿姆斯特朗和他的五个同伙参加了从 1990 年代末开始的长达十年的兴奋剂阴谋。 根据 USADA 的说法，阿姆斯特朗使用了增强性能的药物。 这些指控导致他立即被禁止参加铁人三项比赛。 那年 8 月，他拒绝进入 USADA 的仲裁程序，该程序导致该机构宣布将从 1998 年 8 月起剥夺他的所有奖杯和奖项-包括他的 7 个环法自行车赛冠军-并终身禁止骑自行车 以及遵循《世界反兴奋剂条例》的任何其他运动。 baidu 2012 年 6 月，美国反兴奋剂机构（USADA）指控阿姆斯特朗及其 5 名同伙参与了上世纪 90 年代末开始的十代龙兴奋剂阴谋。根据 USADA 的说法，阿姆斯特朗使用了兴奋剂。这些指控导致他立即被禁止参加铁人三项比赛。同年 8 月，他拒绝参加 USADA 的仲裁程序，这导致该机构宣布，将剥夺他从 1998 年 8 月起的所有奖品和奖项，包括他的七个环法冠军，并颁布终身禁止自行车和任何其他遵循世界反兴奋剂法律的运动。 youdao 2012 年 6 月，美国反兴奋剂机构(USADA)指控阿姆斯特朗和他的五名助手参与了始于 20 世纪 90 年代末的长达 10 年的兴奋剂阴谋。据美国反兴奋剂机构称，阿姆斯特朗使用了提高成绩的药物。这些指控导致他立即被禁止参加铁人三项比赛。当年 8 月他拒绝进入美国的仲裁过程，这导致该机构宣布,它将剥夺了他所有的奖金和奖励从 1998 年 8 月 forward-including 他的七个环法自行车赛主题制定终生禁止骑自行车和其他运动,世界反兴奋剂的代码。 PEMT	2. She copies and pastes the English source text and the three MT outputs to Google Docs for doing PE. Specifically, she reads back and forth between the source text and the three Chinese translations of MT to choose her perception of the most suitable translations as resources for generating her Chinese translation.
In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decadelong doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code.	3. She is not sure about the translation of this word so copies the word.

	5. She pastes the word into Google Translate and gets this Chinese translation '十年(ten years)'.
baidu 2012 年 6 月，美国反兴奋剂机构（USADA）指控阿姆斯特朗及其 5 名同伙参与了上世纪 90 年代末开始的十代龙兴奋剂阴谋。根据 USADA 的说法，阿姆斯特朗使用了兴奋剂。这些指控导致他立即被禁止参加铁人三项比赛。同年 8 月，他拒绝参加 USADA 的仲裁程序，这导致该机构宣布，将剥夺他从 1998 年 8 月起的所有奖品和奖项，包括他的七个环法冠军，并颁布终身禁止自行车和任何其他遵循世界反兴奋剂法律的运动。	6. She is not sure about the meaning of this Baidu output so copies this word.
	7. She pastes the word into Google Translate to get this English translation.
baidu 2012 年 6 月，美国反兴奋剂机构（USADA）指控阿姆斯特朗及其 5 名同伙参与了上世纪 90 年代末开始的十代龙兴奋剂阴谋。根据 USADA 的说法，阿姆斯特朗使用了兴奋剂。这些指控导致他立即被禁止参加铁人三项比赛。同年 8 月，他拒绝参加 USADA 的仲裁程序，这导致该机构宣布，将剥夺他从 1998 年 8 月起的所有奖品和奖项，包括他的七个环法冠军，并颁布终身禁止自行车和任何其他遵循世界反兴奋剂法律的运动。 youdao 2012 年 6 月，美国反兴奋剂机构(USADA)指控阿姆斯特朗和他的五名助手参与了始于 20 世纪 90 年代末的长达 10 年的兴奋剂阴谋。据美国反兴奋剂机构称，阿姆斯特朗使用了提高成绩的药物。这些指控导致他立即被禁止参加铁人三项比赛。当年 8 月他拒绝进入美国的仲裁过程，这导致该机构宣布,它将剥夺了他所有的奖金和奖励从 1998 年 8 月 forward-including 他的七个环法自行车赛主题制定终生禁止骑自行车和其他运动,世界反兴奋剂的代码。 PEMT 2012 年 6 月，美国反兴奋剂机构（USADA）指控阿姆斯特朗及他五名同伙参与了始于 90 年代末的长达十年的兴奋剂阴谋。	8. She makes her translation for the first sentence after comparing the three MT outputs and looking up the meaning of words in Google Translate. (It seems that Lisa marks the translation she is not sure of in red. PEMT at the bottom left of the screen means post-editing of machine translation. This term was used at the beginning of the study but was subsequently replaced with MT+PE.)
	9. She uses Google to translate this term.

	10. She uses Baidu to translate this term.
	11. She looks in Baidu at sample sentences using this term.
PEMT 2012 年 6 月，美国反兴奋剂机构（USADA）指控阿姆斯特朗及他五名同伙参与了始于 90 年代末的长达十年的兴奋剂阴谋。根据美国反兴奋剂机构的说法，阿姆斯特朗使用了运动增强药物/提高运动成绩的药物	12. She writes down two possible translations for this term.
PEMT 2012 年 6 月，美国反兴奋剂机构（USADA）指控阿姆斯特朗及他五名同伙参与了始于 90 年代末的长达十年的兴奋剂阴谋。根据美国反兴奋剂机构的说法，阿姆斯特朗使用了运动增强药物/提高运动成绩的药物。这些指控导致他立即被禁止参加三项比赛。	13. She looks at the three MT outputs for the word ‘triathlon’ and translates it to Chinese ‘三项比赛(three items competition)’. She is not sure if this translation is appropriate so copies this word.
	14. She pastes the word ‘三项比赛(three items competition)’ into Google Search to access Google Image to check the meaning.

	15. She returns to Google Search to look for information about this term. (She does not appear to notice the appropriate Chinese terms in the search results are '三項全能, triathlon' or '三項鐵人, triathlon' not '三项比赛, three items competition'.)
	16. She uses Google Search to look for information about 'World Anti-Doping Code'.
	17. She finds this Chinese translation for this term in the search results.
	18. She finishes her translation and copies it from Google Docs.

3. Lance Armstrong (AMERICAN CYCLIST) In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decadelong doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code. 3. 兰斯·阿姆斯特朗（美国前职业公路自行车赛车手） 2012 年 6 月，美国反兴奋剂机构（USADA）指控阿姆斯特朗及他五名同伙参与了始于 90 年代末的长达十年的兴奋剂阴谋。根据美国反兴奋剂机构的说法，阿姆斯特朗使用了运动增强药物/提高运动成绩的药物。这些指控导致他立即被禁止参加三项比赛。当年/同年 8 月，他拒绝进入 USADA 的仲裁程序，这导致该机构宣布，将剥夺他从 1998 年 8 月起他所有的奖品与奖项，包括他的七个环法自行车赛冠军。此外，也终身禁止他参加自行车以及任何遵循《世界反兴奋剂条例》的运动比赛。	19. She pastes her translated text into the task sheet for editing. (She returns to edit this text after finishing the four text translations.)
¶ Standaard ¶ Geen afs... Kop 1 Kop 2 Alinea Stijlen (USADA) alleged that Armstrong and five of his associates had been part of a decadelong doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code. 2012 年 6 月，美国反兴奋剂机构（USADA）指控阿姆斯特朗及他五名同伙参与了始于 90 年代末的长达十年的兴奋剂阴谋。根据美国反兴奋剂机构的说法，阿姆斯特朗使用了提高运动成绩的药物。这些指控导致他立即被禁止参加三项比赛。同年 8 月，他拒绝进入 USADA 的仲裁程序，这导致该机构宣布，将剥夺他从 1998 年 8 月起他所有的奖品与奖项，包括他的七个环法自行车赛冠军。此外，也终身禁止他参加自行车以及任何遵循《世界反兴奋剂条例》的运动比赛。	20. She edits and finalises her translation. (The changes she makes are marked in yellow.)

Across Table 5.4, Lisa's MT+PE process in the English to Chinese translation consisted of three steps. First, she employed different MT tools (Google, Baidu, and Youdao) to obtain varied translation versions as points of reference. Second, she evaluated MT accuracy based on the source text. To accomplish this, she carefully read back and forth between the English source text and Chinese translations provided by various MT tools. Lisa cross-checked and cross-referenced different MT outputs and looked for meanings or translations of words/phrases using the Google search engine. Third, she generated her translation by selecting her perceptions of the most appropriate MT output as resources and editing MT output when needed. Figure 5.4 shows Lisa's MT+PE process. As in Rory's example, steps two and three are a repeated cycle for each language unit being translated.

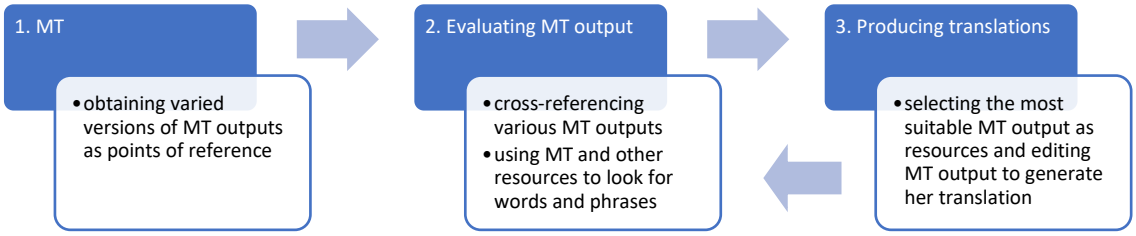


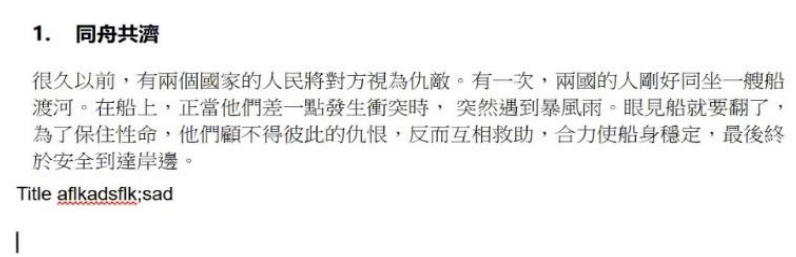
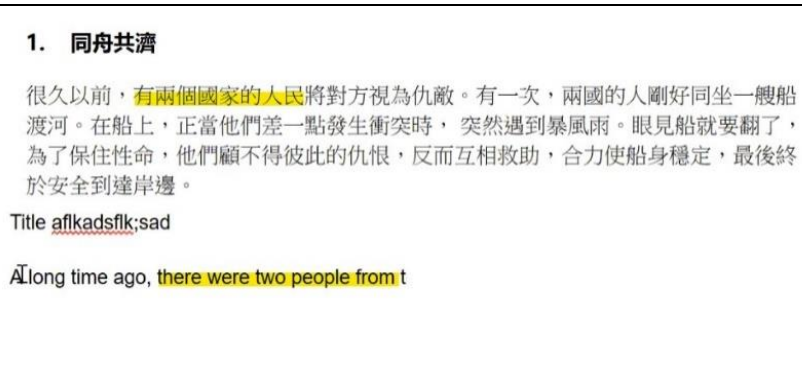
Figure 5.4 Lisa's MT+PE process in the post-intervention task

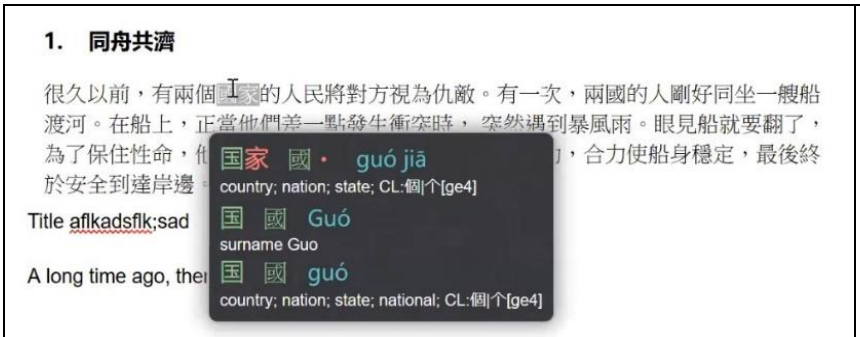
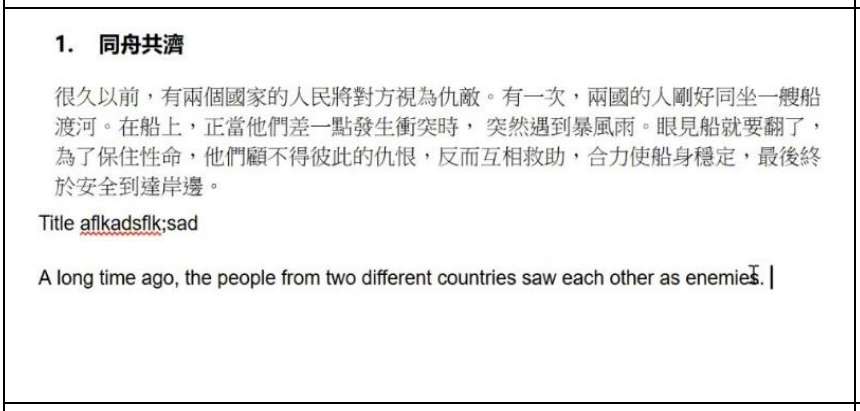
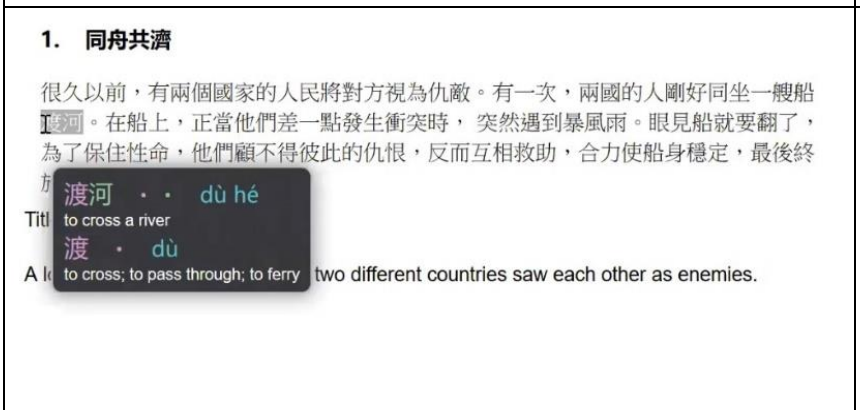
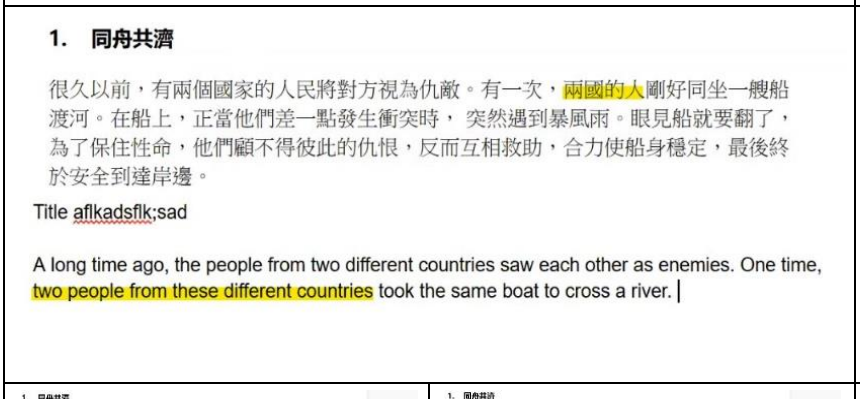
Comparison of the translation processes between the pre- and post-intervention tasks shows that when Lisa undertook HT in the pre-intervention task, she used Google Translate to assist with words and phrases. She adopted MT+PE as a strategy combination to solve translation difficulties and then returned to HT after the problem was solved. In the post-intervention task Lisa changed her approach to use multiple MT tools to generate translations. In adopting this approach, Lisa seemed to shift her focus more towards evaluating varied MT outputs with the use of more tools to judge MT accuracy. The reason that Lisa adopted HT to complete the Chinese to English translation of Text 2 in both pre- and post-intervention tasks might be because she believes HT to be more suitable to translate literary texts, as she indicated in the focus group interview, 'When I translate literary texts, I would use HT'. However, she continued to use MT+PE to complete the Text 4 literary translation from English to Chinese. One possible explanation for this might be that Lisa's English was better than her Chinese language, and that she found MT+PE more effective to complete translation into the target language (Chinese) in which she was less fluent. This finding is discussed later together with other data sources in Section 5.1.2.

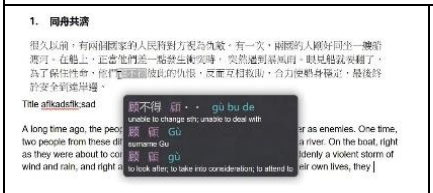
5.1.1.3 Maggie – L1 English speaker and L2 Chinese learner at a B2 level

Maggie adopted HT without the use of MT to complete the four translations in the pre-intervention task and the two Chinese to English translations in the post-intervention task. She used the Firefox browser Chinese-English pop-up dictionary to help her understand the Chinese text. Regarding English to Chinese translations, Maggie consulted Pleco and/or the Google search engine to look for words and phrases to assist with translating into Chinese. She returned to HT once she found the information about words/phrases. Table 5.5 presents the screenshots of Maggie's HT process with Text 2 (Chinese to English translation) in the pre-intervention task.

Table 5.5 Screenshots of Maggie's HT process with Text 2 in the pre-intervention task

Screenshots	Commentary
	1. Maggie copies and pastes this Chinese source text into Google Docs. (She says after the task that she can use the Firefox browser Chinese-English pop-up dictionary in Google Docs but not in Word.)
	2. She uses the pop-up dictionary to look up the meaning for this idiomatic expression.
	3. She is still not sure how to translate this expression so types a placeholder for the title.
	4. She starts to translate this text through HT but mistranslates this phrase.

	5. She looks up this word using the pop-up dictionary.
	6. She corrects her translation and finishes the translation for the first sentence.
	7. She reads with the pop-up dictionary and uses it to look up the meaning of words.
	8. She mistranslates this phrase. (The source text means ‘people from these two countries’.)
	9. She reads with the dictionary.

1. 同舟共濟 很久以前，有兩個國家的人民將對方視為仇敵。有一次，兩國的人剛好同坐一艘船渡河。在船上，正當他們差一點發生衝突時， 突然遇到暴風雨。眼見船就要翻了，為了保住性命，他們顧不得彼此的仇恨，反而互相救助，合力使船身穩定，最後終於安全到達岸邊。 Title aflkadsflk;sad A long time ago, the people from two different countries saw each other as enemies. One time, two people from these different countries took the same boat to cross a river. On the boat, right as they were about to come in conflict with one another, there was suddenly a violent storm of wind and rain, and right away the boat flipped over.	10. She mistranslates this sentence. (The source text means 'seeing that the boat was about to capsize'.)
 	11. She reads with the dictionary.
1. 同舟共濟 很久以前，有兩個國家的人民將對方視為仇敵。有一次，兩國的人剛好同坐一艘船渡河。在船上，正當他們差一點發生衝突時， 突然遇到暴風雨。眼見船就要翻了，為了保住性命，他們顧不得彼此的仇恨，反而互相救助，合力使船身穩定，最後終於安全到達岸邊。 Crossing the river in the same boat A long time ago, the people from two different countries saw each other as enemies. One time, two people from these different countries took the same boat to cross a river. On the boat, right as they were about to come in conflict with one another, there was suddenly a violent storm of wind and rain, and right away the boat flipped over. In order to save their lives, they were unable to persist in this hate, and helped one another, cooperating to stabilize the hull of the boat and then finally safely reaching the shore.	12. She finishes her translation through HT. (She does not translate this Chinese word '反而, instead', which is the key in the source text to pointing to a contrary action.)

The screenshots of this Chinese to English translation process show Maggie reading the Chinese text with help of the pop-up dictionary, using the dictionary to look up meanings of Chinese words/phrases while reading. However, despite the use of the pop-up dictionary, Maggie misunderstood some parts of the source text or did not completely retain the sense of the source text in her translation because of neglecting keywords (e.g., *反而, instead*). Figure 5.5 shows Maggie's process of HT in the pre-intervention task.

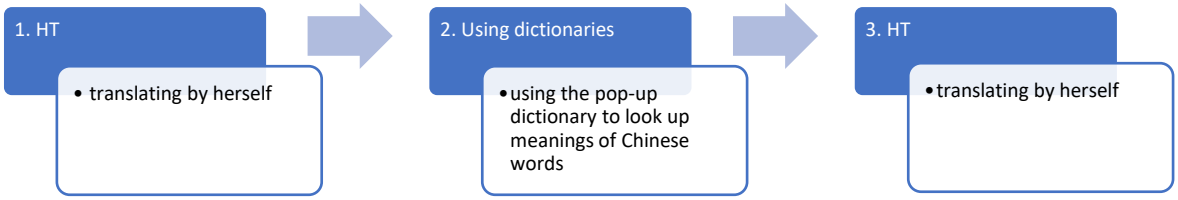
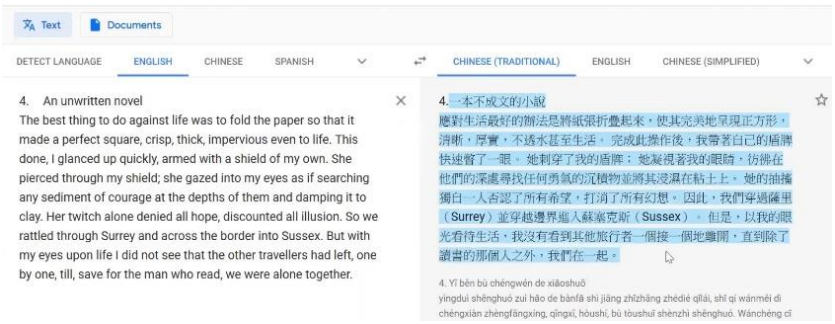
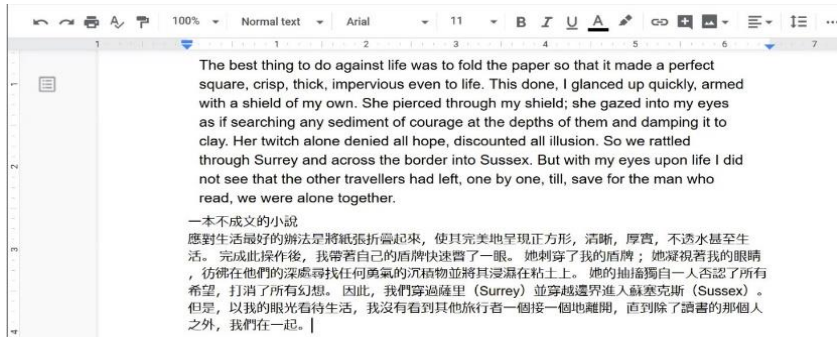
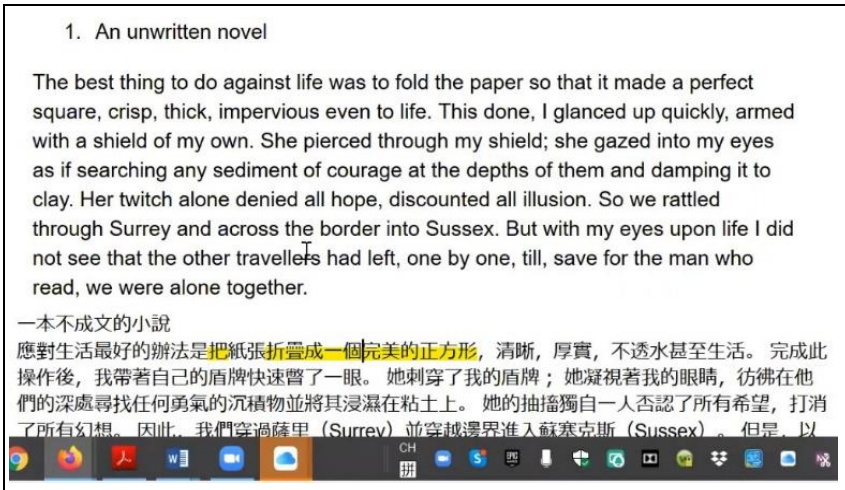
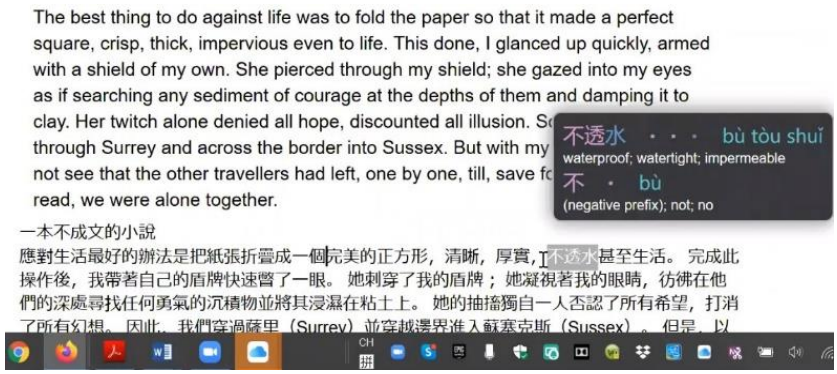
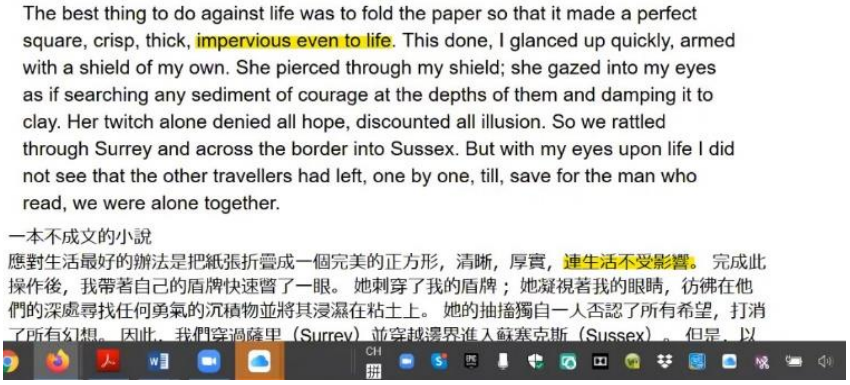


Figure 5.5 Maggie's HT process in the pre-intervention task

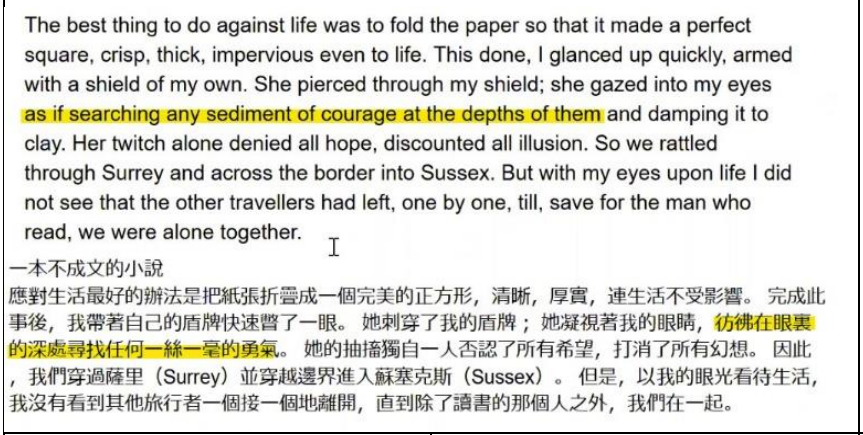
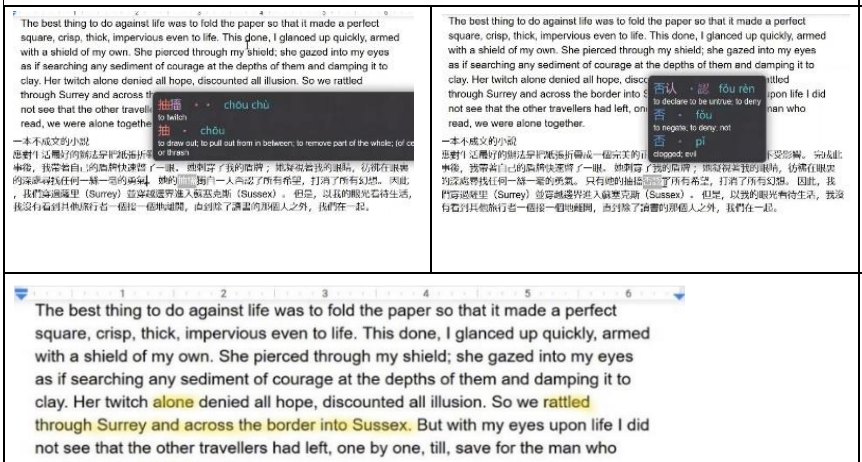
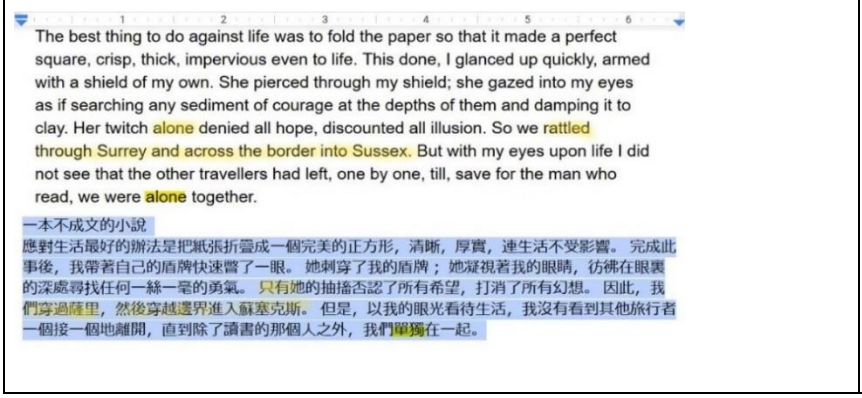
In the post-intervention task, Maggie employed MT+PE with Google Translate to complete two English to Chinese translations. Table 5.6 shows the screenshots of Maggie's MT+PE process with Text 4 (English to Chinese translation) in the post-intervention task.

Table 5.6 Screenshots of Maggie's MT+PE process with Text 4 in the post-intervention task

Screenshots	Commentary
	1. Maggie obtains a paragraph Chinese translation from MT (Google Translate).
	2. She copies and pastes the English source text and the MT Chinese text into Google Docs to do PE.
	3. She reads the source text and then the MT Chinese text with the pop-up dictionary.

	4. She edits the first part of the MT ouput. (She edits this MT output to a more suitable translation in terms of situational appropriateness[18].)
	5. She looks up the meaning for this MT output. (Following the use of the pop-up dictionary, the cursor pauses while she uses the Pleco dictionary app on her phone.)
	6. She edits the MT output. (This edited translation is intelligible, but the meaning has changed to ‘even life is not affected’.)

[18] Situational appropriateness is one of the categories for assessing students’ translations as indicated in Chapter 4. It refers to the ability to use words/phrases appropriately based on sociocultural references, discourse, and register.

	7. She reads the MT Chinese text with the pop-up dictionary to look up the meanings of words. (After using the dictionary, the cursor pauses while she uses Pleco.)
	8. She edits the MT output. (This edited translation reads more naturally in terms of situational appropriateness, although she does not translate the last part of the sentence.)
	9. She reads the MT text with the dictionary.
	10. She edits the MT output and finishes post-editing. (The MT output reads slightly better after editing in terms of source text meaning and situational appropriateness. But the first ‘alone’ should translate to ‘僅僅…就…’ to emphasise purpose.)

As evidenced in Table 5.6, Maggie's MT+PE process in the English to Chinese translation comprised three steps. First, she adopted Google Translate to obtain an entire paragraph translation in Chinese to use as a draft. Second, she evaluated MT accuracy based on the source text. To do so, Maggie read the MT Chinese output with the pop-up dictionary as if she was performing HT for the Chinese to English translation. She also employed other resources such as Pleco to look up words. Third, she modified and/or edited MT output. Figure 5.6 presents Maggie's MT+PE process in the post-intervention task. Again, steps two and three are a repeated cycle for language units being translated.

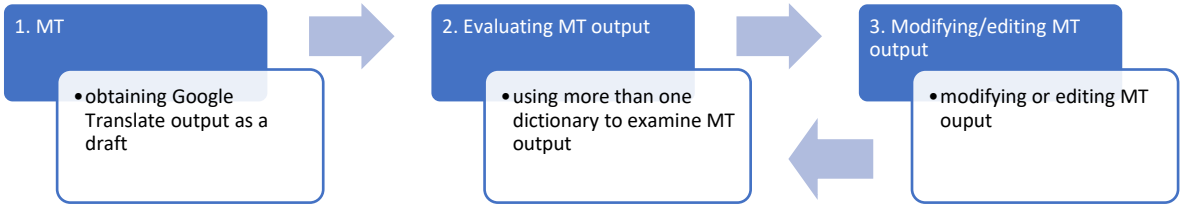


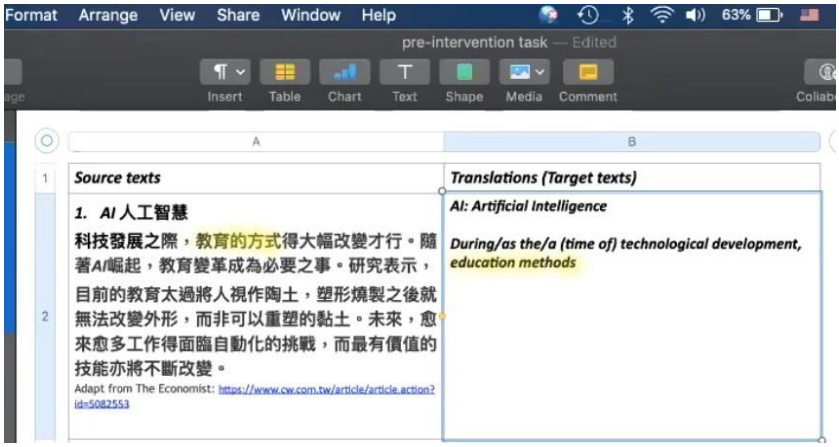
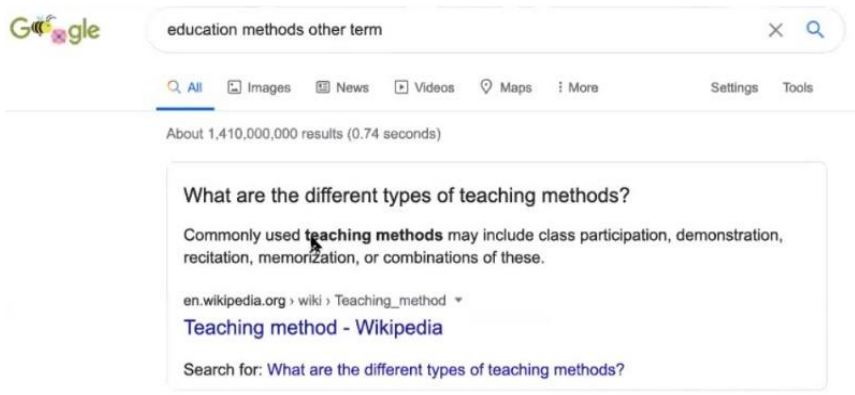
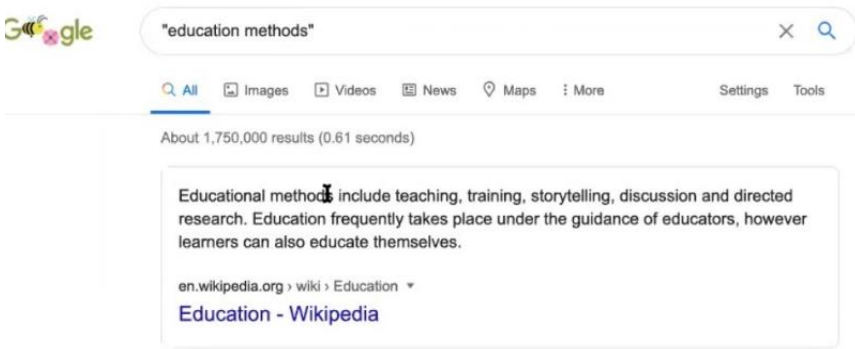
Figure 5.6 Maggie's MT+PE process in the post-intervention task

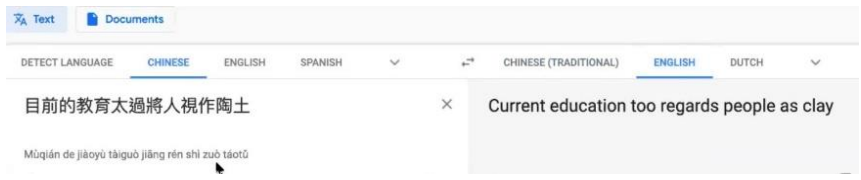
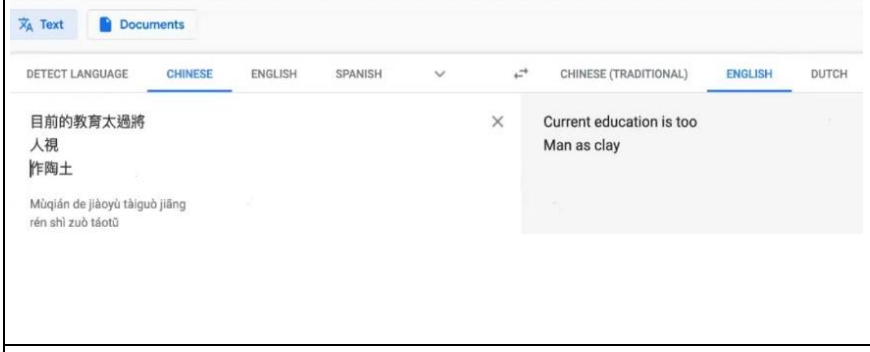
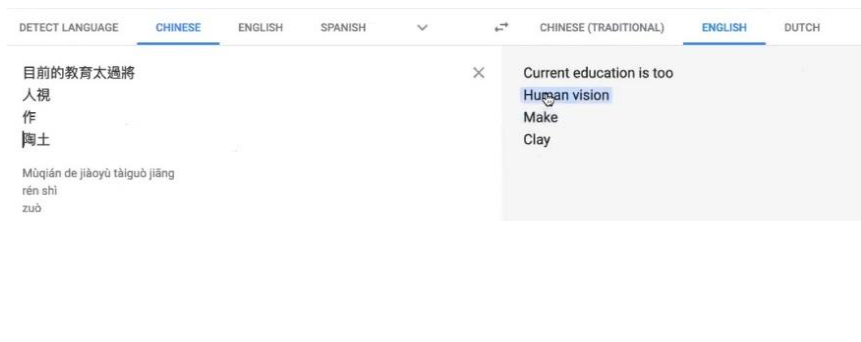
Comparing the translation processes between the pre- and post-intervention tasks shows that Maggie used the pop-up dictionary both to understand the source text in Chinese and to produce Chinese to English translation through HT. Likewise, she employed the same pop-up dictionary together with the Pleco dictionary app to evaluate MT produced output in Chinese and to complete English to Chinese translation through MT+PE. This suggests that her strategy of MT+PE use focuses on reading (Zhang & Torres-Hostench, 2022), evaluating the MT text, and then modifying the MT output with the use of additional resources.

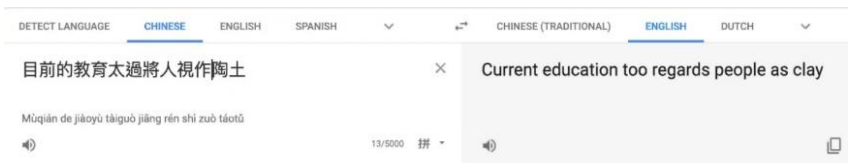
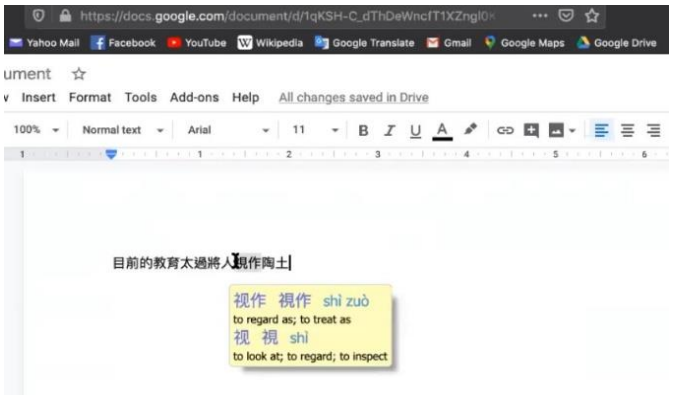
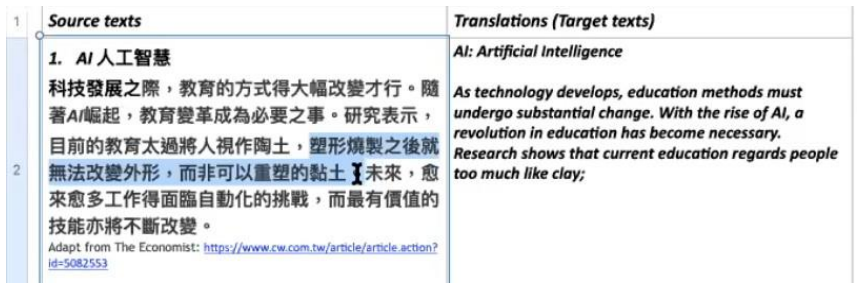
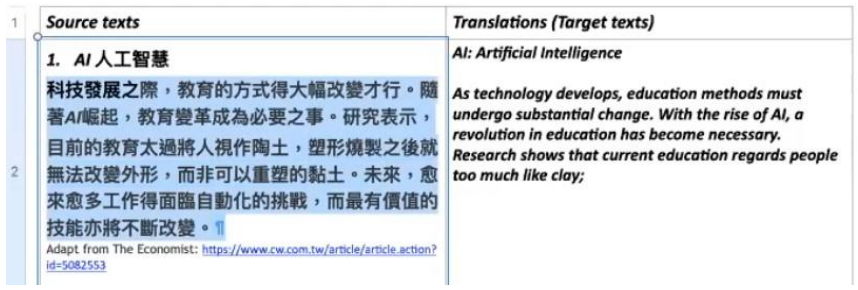
5.1.1.4 Amanda – L1 English speaker and L2 Chinese learner at a B2 level

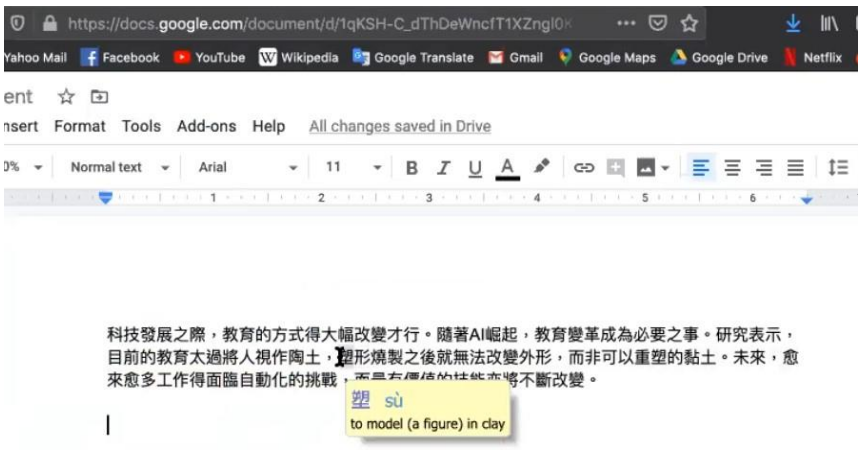
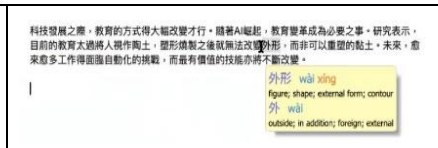
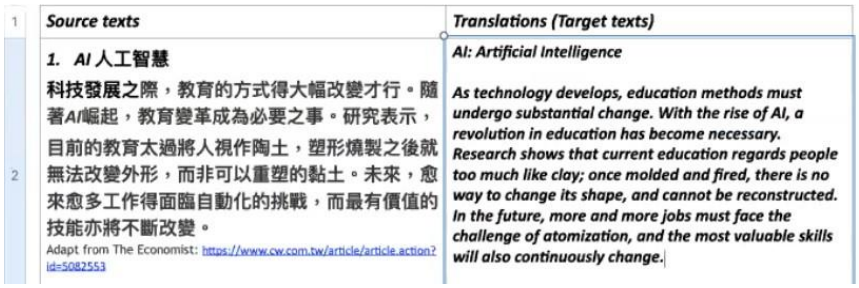
Amanda used HT to translate Text 1 and MT+PE to translate the other three texts in both pre- and post-intervention tasks. When using HT for Text 1, she adopted the Firefox browser Chinese-English pop-up dictionary to look up meanings of words and the Google search engine to look for specific terms and their definitions. Like Lisa, Amanda adopted MT+PE with Google Translate when encountering difficulties in HT. When using MT, she used the pop-up dictionary to double-check MT output. She then returned to HT when the translation problem was resolved. After completing an entire text translation through HT, she used MT to check against her HT output to help with revisions. Table 5.7 shows the screenshots of Amanda's HT process with Text 1 (Chinese to English translation) in the pre-intervention task.

Table 5.7 Screenshots of Amanda's HT process with Text 1 in the pre-intervention task

Screenshots	Commentary
	1. Amanda translates through HT to this point and is not sure about her translation for this term.
	2. She uses the Google search engine to look for alternatives for this term.
	3. She types this term with quotation marks in the Google search bar to look for the definition of this term.

	4. She finishes the translation for the first sentence.
	5. She gets stuck on this sentence.
	6. She translates this sentence using MT (Google Translate).
	7. She splits the sentence into smaller language units in MT. (Like Rory, she appears to segment the phrase as: renshi/zuotaotu. The correct segmentation is: jiang/ren/shizuo/taotu.)
	8. She splits the sentence into smaller language units again. (This shows a continuing Chinese word segmentation problem as she retains ‘renshi’, which is not a word in Chinese.)

	9. She puts the Chinese characters back into the same sentence to see a whole sentence translation in MT. (She appears unsure about this MT output.)
	10. She copies and pastes the sentence into Google Docs to use the Firefox browser Chinese-English pop-up dictionary to look up words while reading. (The pop-up dictionary seems to have helped her understand that ‘shizuo’ is a two-character word and it means ‘regard as’.)
	11. She finishes translating this challenging sentence. (This shows that Amanda performs MT+PE to make MT output more appropriate.)
	12. She is stuck on this sentence.
	13. She copies the entire Chinese source text.

	14. She pastes the copied source text into Google Docs to read the text with the pop-up dictionary.
 	15. She reads with the dictionary and uses it to look up the meaning for individual words.
	16. She finishes her translation.
	17. She uses MT to translate and view an entire paragraph translation in English.
	18. She changes her original translation ‘a revolution in education’ to ‘education reform’.

The example of this Chinese to English translation process reveals that Amanda has expertise in using technological resources to find an answer to her linguistic inquiries. This is reflected

in many ways in her translation process. First, Amanda used quotation marks around the search phrase on the Google search engine to look for results containing that phrase. Second, she used Google Translate for a sentence translation followed by PE when having difficulties translating the source sentence, as Lisa did. Third, when she ran into a Chinese word segmentation problem in a sentence, she put back the characters into the same sentence on Google Translate and used the pop-up dictionary to double-check the meaning of words in that sentence. Fourth, she consulted MT output to revise her own HT output, as Rory did. These practices demonstrate Amanda's strategic use of technological resources, particularly Google Search and Google Translate, to solve her linguistic problems in translation. Figure 5.7 displays Amanda's HT process in the pre-intervention task.

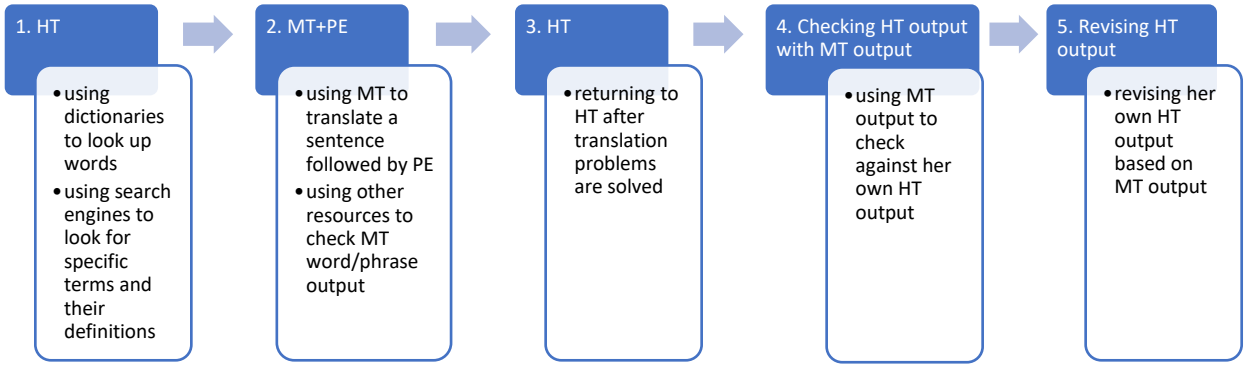
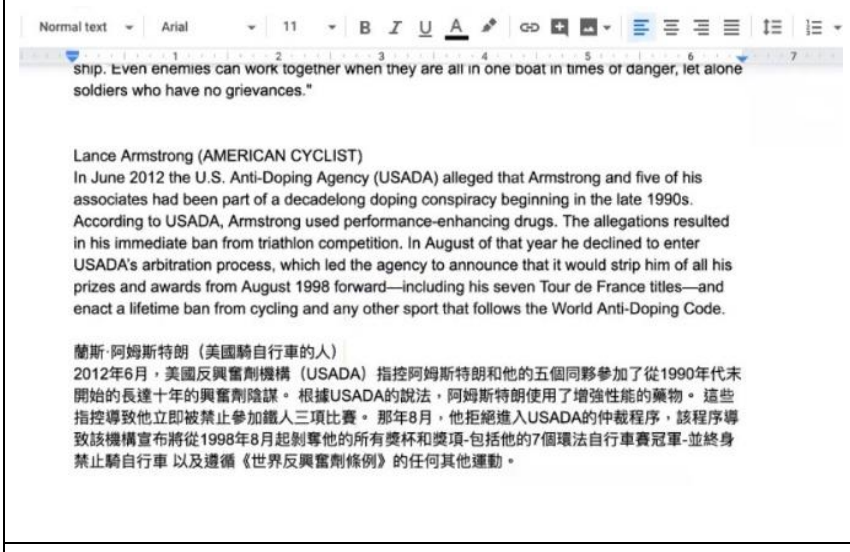
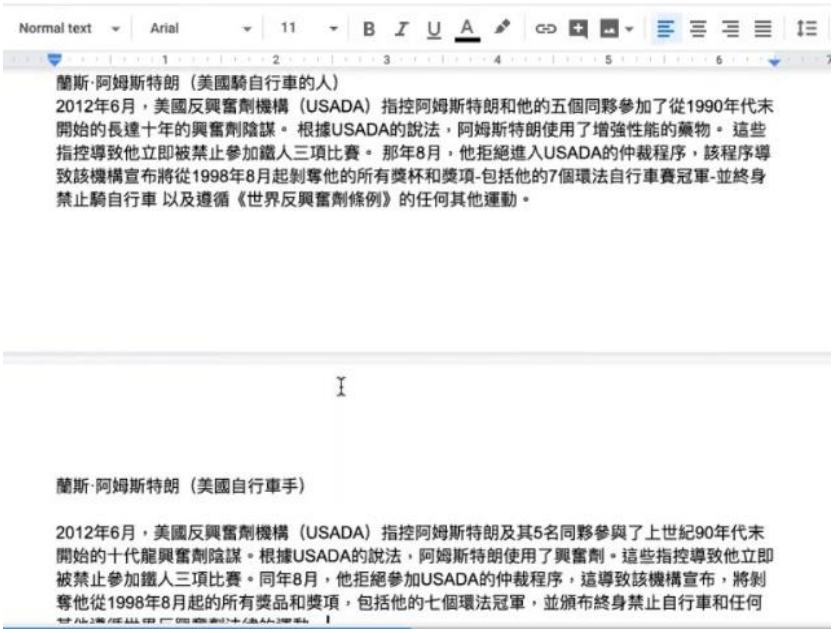


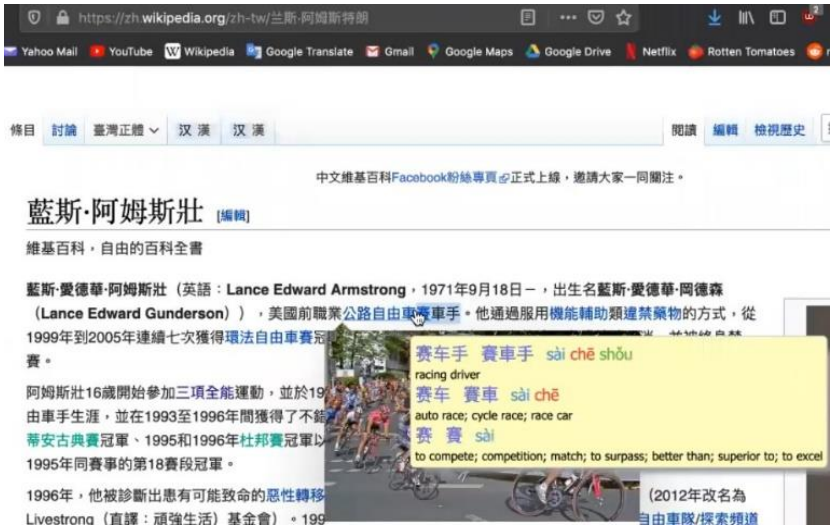
Figure 5.7 Amanda's HT process in the pre-intervention task

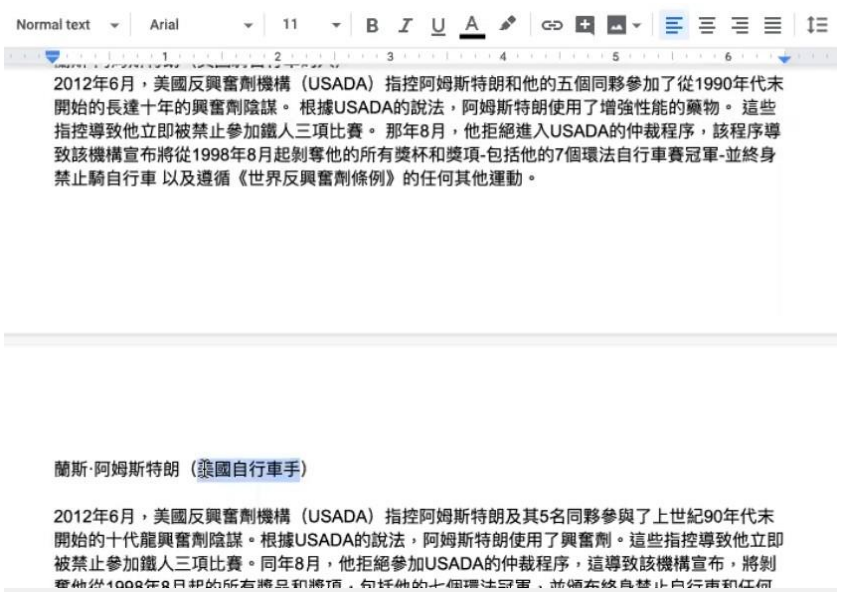
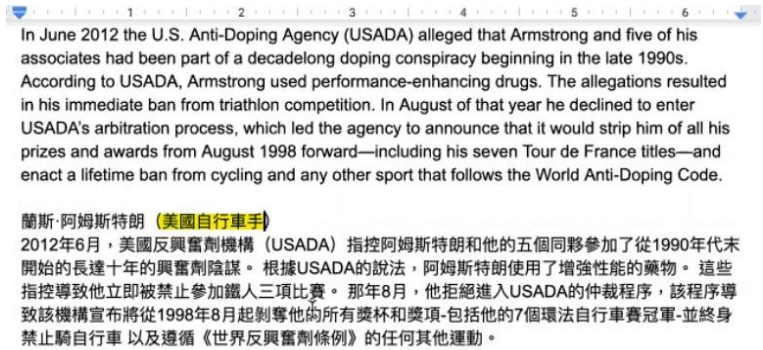
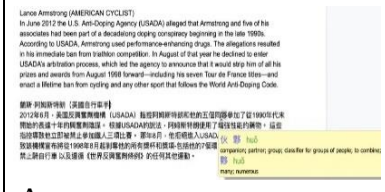
When using MT+PE, Amanda paid attention to evaluating MT accuracy by consulting the same resources mentioned above. The difference between pre- and post-tasks was that she used only Google Translate in the pre-intervention task but adopted two tools (Google and Baidu) in the post-intervention task. Table 5.8 shows the screenshots of Amanda's MT+PE process with Text 3 (English to Chinese translation) in the post-intervention task.

Table 5.8 Screenshots of Amanda's MT+PE process with Text 3 in the post-intervention task

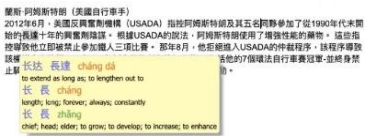
Screenshots		Commentary
 A	 B	1. Amanda obtains paragraph translations in Chinese from two MT tools: A Google B Baidu

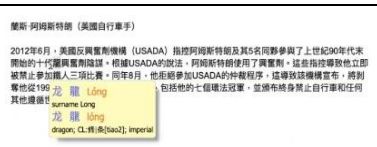
	2. She copies and pastes the English source text and the Chinese output from Google Translate into Google Docs to do PE.
	3. She places the Baidu output under the Google output for cross-checking and comparison.
	4. She employs Wikipedia to look for information about ‘Lance Armstrong’.

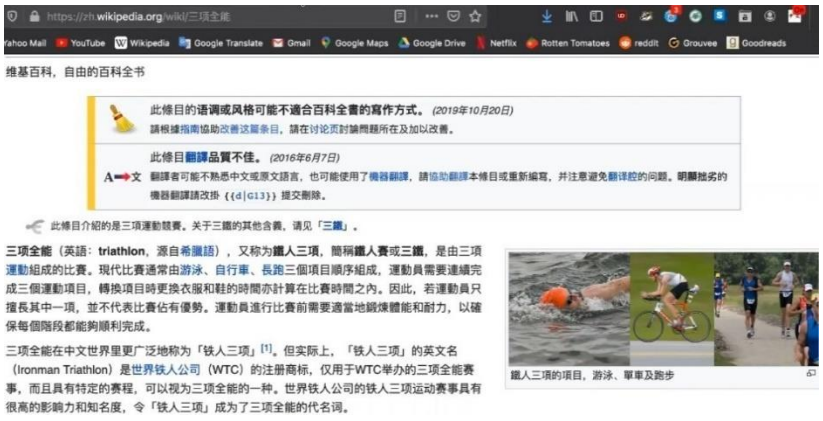
	5. She picks ‘中文, (Chinese)’ under the languges selection to display this text.
	4. She finds this term ‘自由車賽車手, road racing cyclist’ in Wikipedia.
	5. She types this term with quotation marks in the Google search bar to see results. (She seems unsure if this term is suitable.)

	6. She looks at the translation from Baidu for this term and copies it.
	7. She pastes the Baidu output into the Google text. (She replaces the Google output with the Baidu output for this term.)
 A	 B	8. She reads the Google text (marked as A) with the pop-up dictionary followed by reading the Baidu text (marked as B) with the same dictionary. (She seems to compare the two MT texts.)
 A	 B	

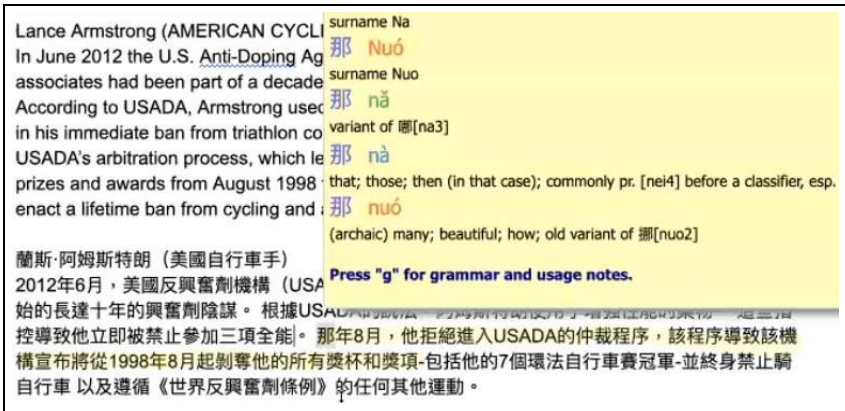
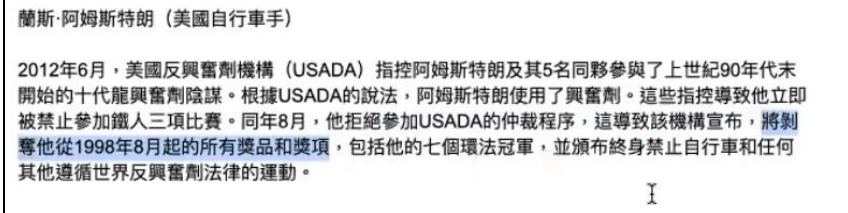
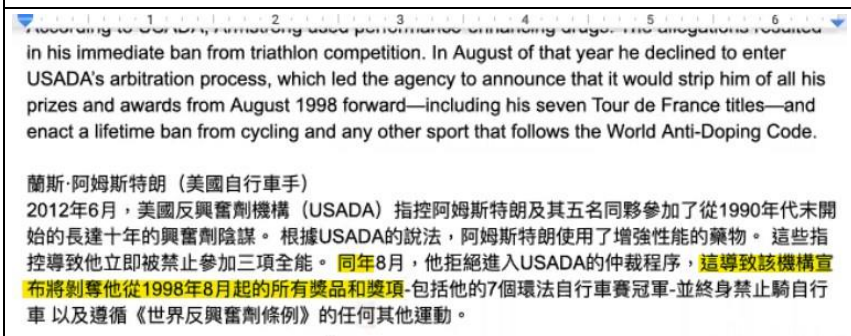
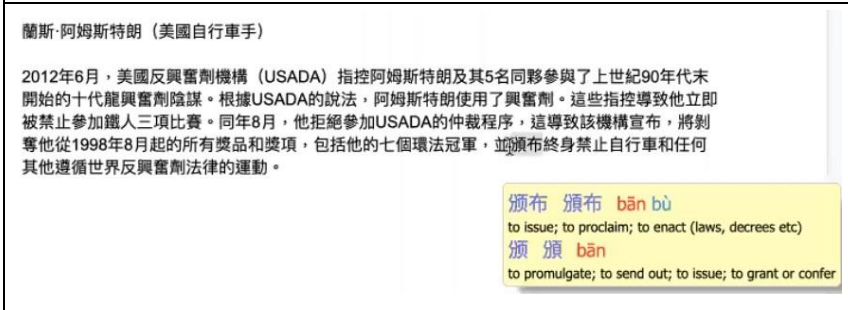
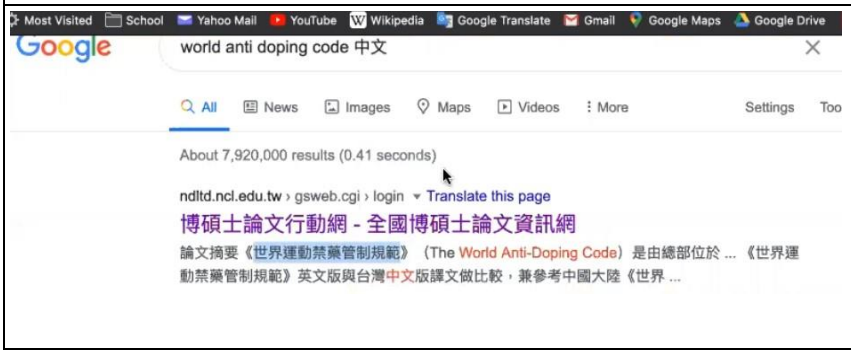
<table>
<tr>
<td>
</td>
<td>9.
She edits this Google ouput using the Baidu output.

(She appears to believe this word choice in Baidu is more appropriate in the context; therefore, she replaces the Google output with this Baidu output.)</td>
</tr>
<tr>
<td>

A


B</td>
<td>10.
She continues to read the Google text (A) and Baidu text (B) with the use of the pop-up dictionary.</td>
</tr>
<tr>
<td>
</td>
<td>11.
She uses Wikipedia in Chinese to look for translation for the word ‘triathlon’.</td>
</tr>
<tr>
<td>Lance Armstrong (AMERICAN CYCLIST)
In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decadelong doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code.

蘭斯·阿姆斯特朗（美國自行車手）
2012年6月，美國反興奮劑機構（USADA）指控阿姆斯特朗及其五名同夥參加了從1990年代末開始的長達十年的興奮劑陰謀。根據USADA的說法，阿姆斯特朗使用了增強性能的藥物。這些指控導致他立即被禁止參加三項全能。那年8月，他拒絕進入USADA的仲裁程序，該程序導致該機構宣布將從1998年8月起剝奪他的所有獎杯和獎項-包括他的7個環法自行車賽冠軍-並終身禁止騎自行車 以及遵循《世界反興奮劑條例》的任何其他運動。</td>
<td>12.
She changes the Google output ‘鐵人三項比賽’ to ‘三項全能’ from Wikipedia for the translation of ‘triathlon’.</td>
</tr>
</table>

	13. She reads this Google sentence output with the dictionary. (She appears to detect mistranslation of this sentence.)
	14. She reads the Baidu sentence output and then copies this part.
	15. She pastes the copied text into the Google text and also edits it based on the Baidu text, as highlighted in yellow. (She appears to recognise that the Baidu output for this sentence is more accurate.)
	16. She reads the last sentence of Baidu and looks up the meaning for this word. (She seems to find this word unsuitable in context.)
	17. She finds a Chinese translation for this term by typing ‘world anti doping code 中文(Chinese)’ in the search bar.

蘭斯·阿姆斯特朗（美國自行車手） 2012年6月，美國反興奮劑機構（USADA）指控阿姆斯特朗及其五名同夥參加了從1990年代末開始的長達十年的興奮劑陰謀。根據USADA的說法，阿姆斯特朗使用了增強性能的藥物。這些指控導致他立即被禁止參加三項全能。同年8月，他拒絕進入USADA的仲裁程序，這導致該機構宣布將剝奪他從1998年8月起的所有獎品和獎項，包括他的七個環法自行車賽冠軍，並終身禁止參加自行車以及任何其他遵循《世界運動禁藥管制規範》的運動。	18. She finishes editing the Google text. (The changes she makes are marked in yellow, and include words, phrases, terms, sentences, and punctuation.)

As shown in Table 5.8, Amanda's MT+PE process for the English to Chinese translation in the post-intervention task comprised three main steps. First, she obtained two MT paragraph outputs from Google and Baidu, using the Google-translated text as a draft for PE and the Baidu-translated text for double-checking and comparing. Second, she evaluated MT accuracy based on the source text. To accomplish this, she examined the Google output with the pop-up dictionary followed by cross-checking and comparing the text with the Baidu output. Amanda used the Google search engine to look for translations of specific terms as if she was performing HT. Third, she modified and/or edited the MT output. Figure 5.8 shows Amanda's MT+PE process in the post-intervention task. Steps two and three are a repeated cycle for each language unit being translated.

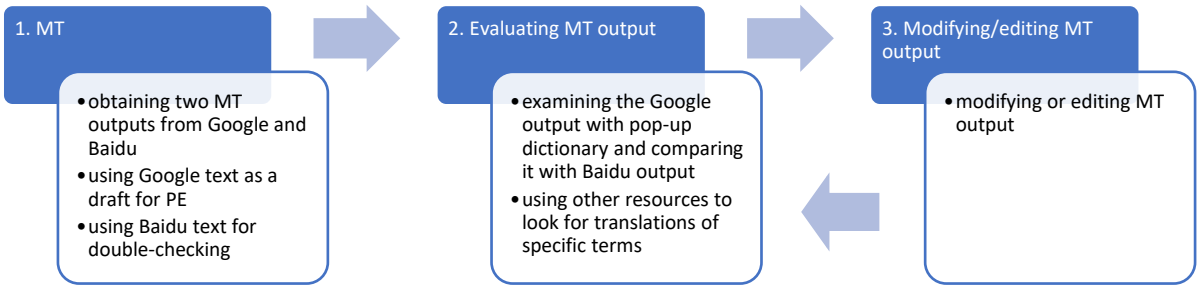


Figure 5.8 Amanda's MT+PE process in the post-intervention task

Amanda's translation processes in both tasks indicate that she was familiar with how to use MT and online resources to assist with translation, including HT and MT+PE. Amanda had already used MT+PE with Google Translate to complete most of the translations in the pre-intervention task, while Rory and Lisa mainly used HT with consultation of MT (Google Translate). This suggests that Amanda was more experienced in the use of MT than the other three students.

In summary, the screen recording data show that three students' translation processes involved the use of MT before the intervention, while all four student participants used MT+PE to varying degrees to complete translations after the intervention. Table 5.9 shows a summary of the students' strategies for using MT in their translation processes.

Table 5.9 Summary of students' strategies for using MT in their translation processes

Students' strategies for using MT in their translation processes	Students
• Using MT to translate words/phrases to look for meanings and/or translations and/or sample sentences when performing HT or MT+PE	Rory, Lisa, Amanda
• Using MT to translate a sentence followed by PE (MT+PE) to solve linguistic and translation problems when performing HT	Lisa, Amanda
• Using MT to translate a paragraph followed by PE (MT+PE) to facilitate translation	Rory, Lisa, Maggie, Amanda
• Comparing MT output with HT output or MT+PE output for assisting revisions	Rory, Amanda

One thing in common among Rory, Lisa and Amanda is that after the teaching intervention they each adopted more than one MT tool to cross-check and cross-reference MT output when evaluating MT accuracy. When using HT as a translation method, the students adopted MT, especially Google Translate, to look up words and phrases, to translate a sentence followed by PE (MT+PE), to solve translation problems, and to check against their HT output for assisting revisions. They adopted other resources such as the Pleco dictionary, pop-up dictionary, and Google search engine to help with words and specific terms and to double-check MT accuracy. When using MT+PE as a translation method, the students used MT to translate a paragraph followed by PE to facilitate translation. In MT+PE, they continued to use MT to look up words and phrases, and to check against their MT+PE output for assisting revisions. The students paid particular attention to MT evaluation with the aid of their commonly used resources to judge MT accuracy and edit inappropriate MT output in the process of MT+PE.

Analyses of the students' use of MT, especially MT+PE, in their translation processes reveal the complexity of metacognitive and metalinguistic processes. MT and PE seem to allow the students to draw on their broader range of linguistic repertoires (at least English and Chinese)

to understand the L2 Chinese source text more fully and to produce the L2 Chinese target text more appropriately. The ability to understand L2 Chinese text is necessary for translation from Chinese to English, and the ability to produce appropriate L2 Chinese production is important for translation from English to Chinese. Understanding how students use MT for translation helps me understand how they apply MT to their L2 Chinese learning context more widely. This is discussed below with multiple data sources.

5.1.2 Students' purposeful use of MT

Findings in relation to the four students' use of MT for their learning of Chinese are presented and discussed in this section. Emerging from the data – comprising screen recordings, focus group interviews, and questionnaires – are five purposeful uses of MT along with related strategies. These five purposeful uses involve students using MT:

1) To look up words or phrases (MT as a multilingual dictionary)

2) To support reading comprehension

3) To support written production

4) To cross-check and evaluate MT output

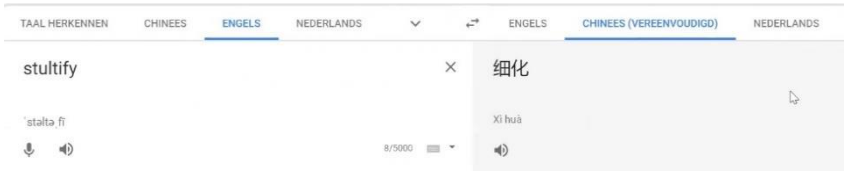
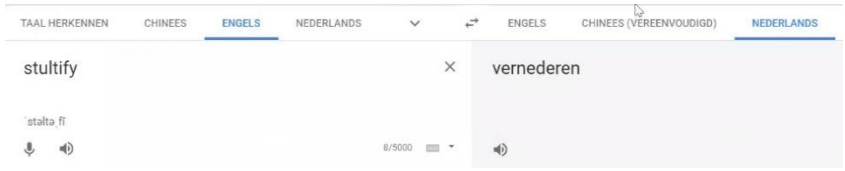
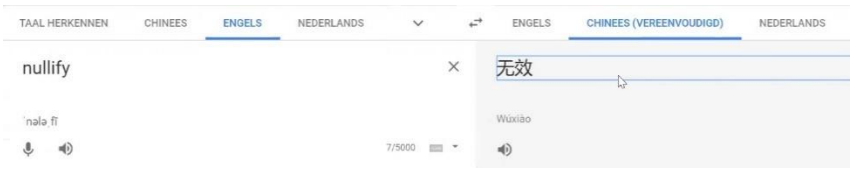
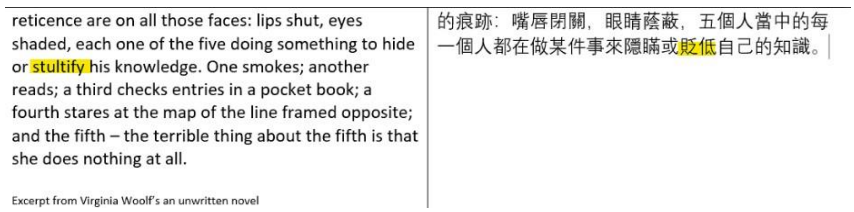
5) To help maintain academic integrity

These uses are ordered here in terms of the size of the language unit involved (from words and phrases to paragraphs, articles and student assignments), and in terms of language function, with reading comprehension preceding purposes related to written L2 production including MT output and academic integrity.

5.1.2.1 Using MT as a multilingual dictionary for words or phrases

For these students, looking up word meanings is usually the first step in making a transfer of text meaning from one language into another. Indeed, according to the screen recording data, three students' (Rory's, Lisa's and Amanda's) primary use of MT was to look for meanings of words or phrases, namely using MT as a multilingual dictionary. As a long-term multilingual speaker, Lisa engaged her Dutch language resources in translating from English to Chinese. Table 5.10 presents screenshots of how Lisa used Google Translate as a multilingual dictionary to look up unknown words in the English to Chinese translation of Text 4.

Table 5.10 Screenshots of Lisa using MT as a multilingual dictionary

Screenshots	Commentary
	1. Lisa uses Google Translate to look up the meaning of this English word. (She appears to find this Chinese translation '*细化*, refine' to be incorrect.)
	2. She translates this word into Dutch.
	3. She translates from Dutch to English.
	4. She translates from English to Chinese (The cursor pauses while she uses Pleco.)
	5. She returns to the task sheet and translates this word into Chinese '贬低, belittle'.

As displayed in Table 5.10, to understand the meaning of the word 'stultify' in the English source text, Lisa used MT to make a three-directional translation from English to Dutch, from Dutch to English, and from English to Chinese. Together with the use of Pleco, she eventually found a more suitable Chinese translation for the English word. In other words, to understand the English word and to find a proximal Chinese equivalent, Lisa employed MT, the Pleco dictionary, and her various linguistic repertoires (L1 Dutch, English, Chinese, and possibly also French within her mind).

When responding to the open-ended item in the post-intervention questionnaire, 'Please write a few sentences or a paragraph to explain how you use PEMT[19] (MT+PE)', Rory and Maggie reported their use of MT to look up words or phrases:

> [I] look up specific terms or expressions (e.g., 'COVID-19') [Rory, questionnaire].
>
> I typically use Baidu to search for example sentences to get a better idea if I know if I am using a word properly…The English in these examples sentences is not very good… Sometimes I won't read the English at all, just the Chinese example sentence [Maggie, questionnaire].

Thus, beyond the specific tasks in this study, Rory uses MT to assist with the translation of words, phrases, and terminology, while Maggie employs MT to understand how a word is used in context by looking at sample sentences. However, Maggie only refers to Chinese sample sentences because she finds that the English sample sentences on Baidu are not always grammatically accurate. This way of using MT to understand word usage is similar to the way Lisa used Baidu to look at phrase usage, as shown in the screenshot in Figure 5.9 below. Screen recording data show that Lisa made use of Baidu to translate the phrase 'performance enhancing drugs' into Chinese and then referred to the Chinese sample sentence to understand the usage of this phrase.



Figure 5.9 Lisa using Baidu to look for phrase usage

Responses to the closed-ended question[20], 'How frequently do you use MT for translating phrases?' reveal that three students (Rory, Lisa, and Maggie) had increased their frequency of using MT to translate phrases after the intervention (see Appendix 5.1). Amanda's usage remained unchanged in this regard, reporting her occasional use of MT to translate phrases in both pre- and post-intervention questionnaires. The numerical data in the questionnaires

[19] PEMT was used at the early stage of this study but later changed to MT+PE.

[20] Responses to closed-ended questions in pre- and post-intervention questionnaires are used only as supplementary data to support qualitative data.

indicate that after the intervention three out of four students find MT useful for looking up phrases. Interestingly, although Rory indicated in the pre-intervention questionnaire that he had never previously adopted MT to translate words, the results of screen recordings showed that he frequently used MT to look up words and phrases in the pre-intervention task. In short, the multiple data sources showed that the students frequently utilised MT to look up meanings and translations of words and phrases and to understand the usage of words and phrases by referring to sample sentences.

5.1.2.2 Using MT as a resource to support reading comprehension

Going beyond the search for word or phrase meaning and usage, the students purposefully used MT to translate larger language units (e.g., sentences and paragraphs) to help with reading comprehension. Their strategies for supporting reading comprehension include using MT 1) to speed up reading to search for reading materials for more in-depth reading; and 2) to check Chinese reading for improving comprehension.

Speeding up reading to search for reading materials for more in-depth reading

The following data show that students employ MT to speed up reading in Chinese and gain a general meaning of the reading text when they are searching for and evaluating online information in Chinese:

> MT helps me understand a complex Chinese paragraph, in particular when I need to read extensively and quickly, for example, searching for information or news [Rory, questionnaire].

> I would put an article title in the MT to get a rough idea and then decide if I want to read the article [Lisa, interview].

According to these comments, Rory employs MT to speed up reading and understand challenging texts in L2 Chinese when he looks for online materials from a great deal of information on the web. Lisa uses MT to quickly get the gist of a Chinese written text and to decide what to read in more depth, allowing her to accelerate reading, identify the broad meaning of written text, and select useful reading materials. In short, Rory and Lisa draw on MT to accelerate reading for text evaluation and selection. When they locate wanted information, they read it carefully with the use of other tools, as Lisa indicates, ‘if I want to read an article or a paragraph of an article conscientiously, I will use dictionaries’ (focus group interview). This reveals that, after she has selected required reading materials using MT, Lisa will engage in reading activity by herself and by consulting dictionaries.

Checking Chinese reading for improving comprehension

The screen recording data revealed that Rory and Amanda both used MT English output to check their HT output in English after they completed their translations from Chinese to English (see Section 5.1.1). This may indicate that they are not confident with their understanding of the Chinese source text, so they refer to MT English output to check if their Chinese interpretation is accurate. Table 5.11 shows screenshots of Rory using MT to check and improve his Chinese reading comprehension when stuck on the meaning of the underlined Chinese source sentence '*研究表示，目前的教育太過將人視作陶土，塑性燒製之後就無法改變外形，而非可以重塑的黏土* (*Research shows that current education treats people too much like 'hardened clay' that cannot change its shape after it has been moulded and fired, unlike 'wet clay' that can be reshaped)*'.

Table 5.11 Screenshots of Rory using MT to check and improve reading comprehension

Screenshots	Commentary
Source texts 1. AI 人工智慧 科技發展之際，教育的方式得大幅改變才行。隨著 AI 崛起，教育變革成為必要之事。研究表示，目前的教育太過將人視作陶土，塑形燒製之後就無法改變外形，而非可以重塑的黏土。未來，愈來愈多工作得面臨自動化的挑戰，而最有價值的技能亦將不斷改變。 Adapt from The Economist: https://www.cw.com.tw/article/article.action?id=5082553 Translations (Target texts) AI At the cutting edge of technology development, education methods require a significant change. Following AI trends education reform has become necessary. Research suggests that today overly relies on human sight as clay, after the form is fired there's no way to change the shape. In future, more and more work has to face the challenge of automation, and so the most valuable skills will continue changing.	1. Rory finishes HT but seems unsure about the meaning of the underlined Chinese text.
Google Translate Text Documents CHINESE - DETECTED ENGLISH SPANISH FRENCH ENGLISH SPANISH ARABIC 科技發展之際，教育的方式得大幅改變才行。隨著AI崛起，教育變革成為必要之事。研究表示，目前的教育太過將人視作陶土，塑形燒製之後就無法改變外形，而非可以重塑的黏土。未來，愈來愈多工作得面臨自動化的挑戰，而最有價值的技能亦將不斷改變。 Kēji fāzhǎn zhī jì, jiàoyù de fāngshì dé dàfú gǎibiàn cái xíng. Suízhe AI juéqǐ, jiàoyù biàngé chéngwéi bìyào zhī shì. Yánjiū biǎoshì, mùqián de jiàoyù tàiguò jiāng rén shì zuò táotǔ, sù xíng shāo zhì zhīhòu jiù wúfǎ gǎibiàn wàixíng, ér fēi With the development of science and technology, the way of education has to change drastically. With the rise of AI, educational reform has become a necessity. Research shows that current education treats people too much as clay and cannot change its shape after being shaped and fired, rather than clay that can be reshaped. In the future, more and more jobs will face the challenge of automation, and the most valuable skills will continue to change.	2. He consults Google Transate for a whole paragraph translation.
Source texts 1. AI 人工智慧 科技發展之際，教育的方式得大幅改變才行。隨著 AI 崛起，教育變革成為必要之事。研究表示，目前的教育太過將人視作陶土，塑形燒製之後就無法改變外形，而非可以重塑的黏土。未來，愈來愈多工作得面臨自動化的挑戰，而最有價值的技能亦將不斷改變。 Adapt from The Economist: https://www.cw.com.tw/article/article.action?id=5082553 Translations (Target texts) AI With developments in science and technology, education methods must also undergo significant change. Trends in AI have made education reform a necessity. Research shows that today's education treats people too much like clay, with no way to change their initial form after it has been hardened, unable to be re-molded into a new shape. Yet in future, as more and more work faces the challenge of automation, the most valuable skills will continually change.	3. He revises and finalises his translation through HT.

As shown in Table 5.11, after completing translation through HT, Rory referred to Google Translate output in English to check his comprehension of the Chinese source text. By so doing, he found that he had misinterpreted the underlined Chinese source sentence because of Chinese word segmenting problems, as indicated in Table 5.1. He, therefore, made modifications to his original translation. The revised version showed that Rory significantly improved his translation by checking with Google Translate. Although the revised version was not a completely accurate translation, the revision corresponded more closely to the Chinese source text meaning, compared with his original version generated by HT. This example shows that the Chinese word segmentation problem prevented the student from understanding the Chinese source sentence. The problem was only resolved when he consulted MT for a whole paragraph translation in English. This suggests that referring to MT output in English with a larger language unit (a paragraph) helps the student improve his understanding of the Chinese text, thereby improving his L1 English translation.

Responses to the closed-ended question 'How frequently do you use MT for checking what you read in Chinese?' in the pre- and post-intervention questionnaires (see Appendix 5.1) reveal that Lisa and Amanda reported occasional use of MT to check what they read in Chinese. In both the pre- and post-intervention questionnaires Maggie indicated that she had never used MT in this regard. Rory showed a slight increase in the frequency of using MT to check his Chinese reading between the two questionnaires from never to rarely, although the screen recording data showed he used MT in this way in both pre- and post-intervention tasks. Taken together, the screen recordings and numerical data in questionaries reveal that three students (Rory, Lisa, and Amanda) applied MT to check their Chinese reading to improve comprehension both before and after the intervention.

5.1.2.3 Using MT as a resource to support written production

The third purposeful use of MT by these four students is to translate larger language units to help with more accurate L2 Chinese written text production. Their strategies for supporting written production are: using MT to 1) undertake PE (MT+PE) to facilitate translation tasks; 2) check Chinese writing and assist with revisions; and 3) help with conveying intended meaning and expressing ideas in Chinese writing.

Undertaking MT+PE to facilitate translation tasks

As presented in the screen recording data in Section 5.1.1, all the students used MT+PE to complete their translations in the post-intervention tasks. Rory, Maggie, and Amanda used MT

paragraph output as a draft and then modified and/or edited it to complete their translations, while Lisa used different MT paragraph outputs as points of reference followed by selecting what she considered to be the most suitable outputs as resources, and then editing her selected MT outputs to finalise her translation.

The students iteratively mentioned that whether or not they would use HT or MT+PE to complete translation tasks would depend on their *intentions* and the *text types*:

> If it's a literary text, I would directly use HT; if it's a news article or a more formal text, I might use PEMT [MT+PE] [Rory, interview].
>
> For learning Chinese, I would consider using HT to translate from English to Chinese…In the context of translation, I would use PEMT [MT+PE] [Maggie, interview].
>
> When translating literary texts, I mostly use HT…If my purpose is learning, I would probably use HT first and then compare the translation made by HT with the MT translation. But if the purpose is just to complete a translation, I would probably use PEMT [MT+PE] [Amanda, interview].
>
> It depends on the purposes. For learning, I would translate by myself and using the words I know. But if I need to translate more quickly…I think PEMT [MT+PE] is better [Lisa, interview].

From these responses, the students are more likely to use MT+PE in the context of translation or when their purpose is only to produce a translation. On the other hand, when their intentions are *to learn* the Chinese language, they are likely to use HT, possibly followed by comparing HT output with MT output as indicated by Amanda. Thus, students' learning intentions play a role in decisions regarding whether to use HT or MT+PE. In addition to students' intentions, source text types seem to be another factor influencing their decisions to use HT or MT+PE as indicated by Rory and Amanda.

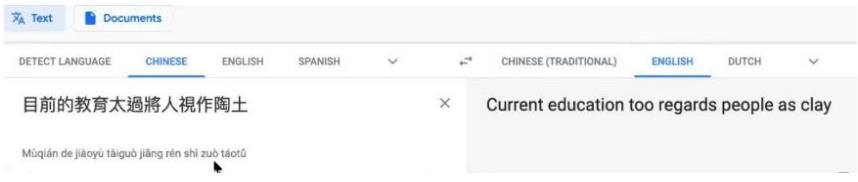
However, regardless of whether it was a literary or non-literary text type, screen recording data show that three students used MT+PE to complete the Chinese to English translation of Text 1 (magazine article) and/or Text 2 (idiomatic story), and four students used MT+PE to complete the English to Chinese translation of Texts 3 (biography) and 4 (short novel) in the post-intervention task (see Section 5.1.1). Analysis of the focus group interview and screen recording data reveals that even though students state that they will use HT to translate literary texts and for the purpose of learning Chinese, in reality they used MT+PE to complete most of their translation tasks. One possible explanation for this result might be that students find MT+PE more effective and efficient to accomplish translations, as indicated by the data below:

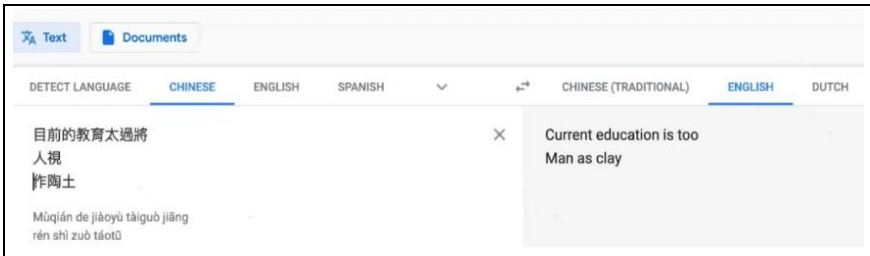
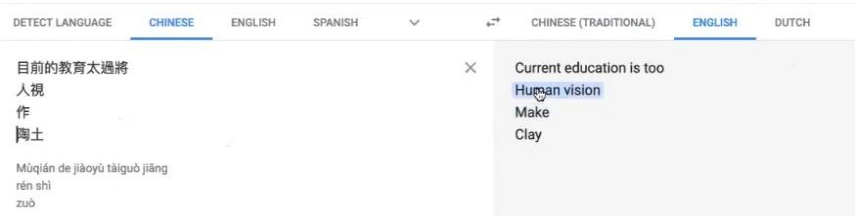
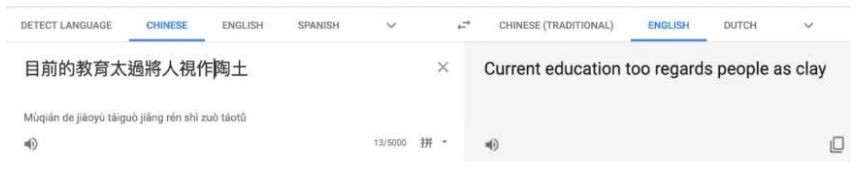
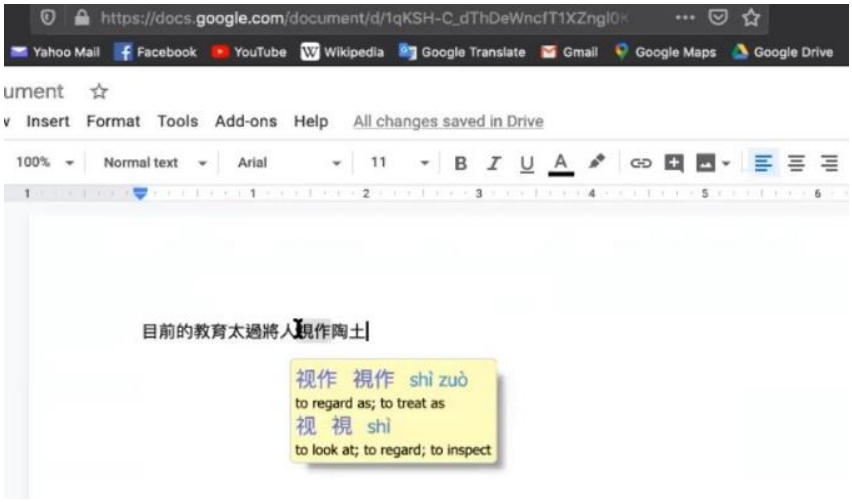
> It [MT+PE] could accelerate translation processes [Rory, interview].
>
> …to translate more quickly… I think PEMT [MT+PE] is better [Lisa, interview].
>
> If the context is to produce translation…I would consider the most convenient and fastest method…The fastest is of course PEMT [MT+PE] [Amanda, interview].

The comments show that the students consider MT+PE to be useful for translation tasks, and that they are very likely to use MT+PE when they translate or need to complete translations swiftly. This finding may suggest that students pay attention to how they can use MT to enhance efficient and effective completion of tasks.

In addition to using MT+PE to complete translation tasks, Lisa and Amanda also applied MT+PE when they encountered difficulties in HT, as indicated in Table 5.3 and Table 5.7. Each student began with HT and changed to MT+PE when having trouble in the transfer of meaning between languages. For example, when Amanda had difficulties in understanding a Chinese source sentence with HT, she used Google Translate to get a raw MT output in English. She then evaluated the MT accuracy followed by editing the MT output to complete her sentence translation (See Table 5.12 below, excerpted from Table 5.7).

Table 5.12 Screenshots of Amanda using MT+PE to solve translation problems when using HT

Screenshots	Commentary
	1. Amanda gets stuck on this sentence.
	2. She translates this sentence using MT (Google Translate).

	3. She splits the sentence into smaller language units in MT. (Like Rory, she appears to segment the phrase as: renshi/zuotaotu. The correct segmentation is: jiang/ren/shizuo/taotu.)
	4. She splits the sentence into smaller language units again. (This shows a continuing Chinese word segmentation problem as she retains ‘renshi’, which is not a word in Chinese.)
	5. She puts the Chinese characters back to the same sentence to see a whole sentence translation in MT. (She appears unsure about this MT output.)
	6. She copies and pastes the sentence into Google Docs to use the Firefox browser Chinese-English pop-up dictionary to look up words while reading. (The pop-up dictionary seems to have helped her understand that ‘shizuo’ is a two-character word and it means ‘regard as’.)

	7. She finishes translating this challenging sentence. (This shows that Amanda performs MT+PE to make the MT output more appropriate.)

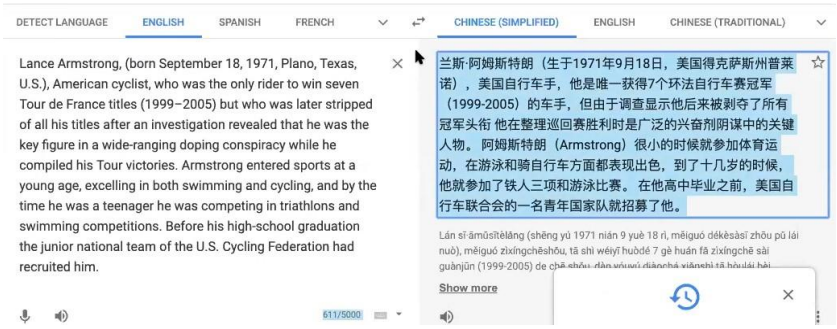
As shown in Table 5.12, Amanda used MT to get the gist of the source sentence and a raw translation, followed by a series of MT evaluations, from Steps 3 to 6. The MT evaluation process involved the use of MT itself and also the pop-up dictionary to look up the meaning of words and phrases to better understand the source text. Following the several steps of MT evaluation, Amanda edited the MT output to complete her sentence translation. This example suggests that in this cognitive and linguistic process the student draws on her repertoire of English and Chinese languages in combination with digital resources (MT and dictionaries) to solve her language problems. The use of language capabilities in two languages and online-based resources seems to help the student bridge the gap between L1 English and L2 Chinese.

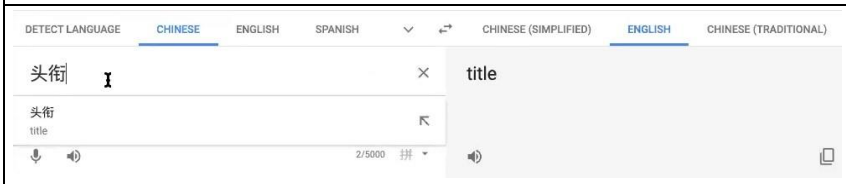
Taken together, multiple data sources show that the students employed MT+PE as a strategy combination when they wanted to complete translation effectively and when they encountered translation problems during HT processes.

Checking Chinese writing and assisting with revisions

Screen recording data show that Rory used MT output in Chinese to check his Chinese translation produced by HT in the pre-intervention task and by MT+PE in the post-intervention task. Table 5.13 presents screenshots of Rory employing Google Translate output to check his HT output in Chinese and to assist with revisions of the first long sentence.

Table 5.13 Screenshots of Rory using MT to check HT output in Chinese and help with revisions

Screenshots	Commentary
3. Lance Armstrong (AMERICAN CYCLIST) Lance Armstrong, (born September 18, 1971, Plano, Texas, U.S.), American cyclist, who was the only rider to win seven Tour de France titles (1999–2005) but who was later stripped of all his titles after an investigation revealed that he was the key figure in a wide-ranging doping conspiracy while he compiled his Tour victories. Armstrong entered sports at a young age, excelling in both swimming and cycling, and by the time he was a teenager he was competing in triathlons and swimming competitions. Before his high-school graduation the junior national team of the U.S. Cycling Federation had recruited him. Source from Encyclopaedia https://www.britannica.com/biography/Lance-Armstrong 蘭斯·阿姆斯特朗（美國騎單車者） 蘭斯·阿姆斯特朗（生於 1971 年 9 月 18 日，美國德州 Plano 市），美國騎單車者，唯一贏過七次環法自由車賽冠軍（1999-2005）而後來由於被檢測發現在獲得環法獎牌的同時也是廣泛的禁藥行為陰謀的關鍵人物，因此所有獎牌取消了。阿姆斯特朗小歲進入運動界，在游泳與騎車都表現優秀，以致青年時已經參與铁人三项和游泳比賽。在他中學畢業前，美國自由車聯合會的青年國家隊已為招	1. Rory finishes HT in Chinese and copies the paragraph-long English source text.
	2. He pastes the source text to MT (Google Translate) to obtain a translation in Chinese, and then copies the MT Chinese output.
3. Lance Armstrong (AMERICAN CYCLIST) Lance Armstrong, (born September 18, 1971, Plano, Texas, U.S.), American cyclist, who was the only rider to win seven Tour de France titles (1999–2005) but who was later stripped of all his titles after an investigation revealed that he was the key figure in a wide-ranging doping conspiracy while he compiled his Tour victories. Armstrong entered sports at a young age, excelling in both swimming and cycling, and by the time he was a teenager he was competing in triathlons and swimming competitions. Before his high-school graduation the junior national team of the U.S. Cycling Federation had recruited him. Source from Encyclopaedia https://www.britannica.com/biography/Lance-Armstrong 蘭斯·阿姆斯特朗（美國騎單車者） 蘭斯·阿姆斯特朗（生於 1971 年 9 月 18 日，美國德州 Plano 市），美國騎單車者，唯一贏過七次環法自由車賽冠軍（1999-2005）而後來由於被檢測發現在獲得環法獎牌的同時也是廣泛的禁藥行為陰謀的關鍵人物，因此所有獎牌取消了。阿姆斯特朗小歲進入運動界，在游泳與騎車都表現優秀，以致青年時已經參與铁人三项和游泳比賽。在他中學畢業前，美國自由車聯合會的青年國家隊已為招 兰斯·阿姆斯特朗（生于 1971 年 9 月 18 日，美国得克萨斯州普莱诺），美国自行车手，他是唯一获得 7 个环法自行车赛冠军（1999-2005）的车手，但由于调查显示他后来被剥夺了所有冠军头衔 他在整理巡回赛胜利时是广泛的兴奋剂阴谋中的关键人物。 阿姆斯特朗（Armstrong）很小的时候就参加体育运动，在游泳和骑自行车方面都表现出色，到了十几岁的时候，他就参加了铁人三项和游泳比赛。 在他高中毕业之前，美国自行车	3. He puts the MT ouput under his HT output to compare. (The words highlighted and underlined are the differences between HT and MT for the first long sentence.)

	4. He uses Google Search to check the MT output ‘自行車手, cyclist’.
	5. He uses Google Search to look for information about this term ‘腳踏車手, cyclist’. (He does not see this term on the search results as this is not a suitable translation for ‘cyclist’.)
	6. He uses MT to look up the meaning of this MT Chinese output.
	7. He uses MT to look up the meaning of this MT Chinese output.
	8. He uses MT to look for a translation of this phrase in the source text and copies it.

	9. He pastes the MT Chinese translation to the Google search bar. (He does not see this phrase on the search results as there is no such word collocation in Chinese.)
3. Lance Armstrong (AMERICAN CYCLIST) Lance Armstrong, (born September 18, 1971, Plano, Texas, U.S.), American cyclist, who was the only rider to win seven Tour de France titles (1999–2005) but who was later stripped of all his titles after an investigation revealed that he was the key figure in a wide-ranging doping conspiracy while he compiled his Tour victories. Armstrong entered sports at a young age, excelling in both swimming and cycling, and by the time he was a teenager he was competing in triathlons and swimming competitions. Before his high-school graduation the junior national team of the U.S. Cycling Federation had recruited him. 蘭斯·阿姆斯特朗（美國自行車手） 蘭斯·阿姆斯特朗（生於 1971 年 9 月 18 日，美國得克薩斯州普萊諾），美國自行車手，是唯一獲得七次環法自由車賽冠軍（1999-2005）的車手，而後來由於檢測發現他在獲得環法獎牌的同時是廣泛禁藥行為陰謀的關鍵人物，因此被剝奪所有冠軍頭銜。阿姆斯特朗小歲進入運動界，在游泳與騎車都表現出色，以致青年時已經參加铁人三项和游泳比賽。在他高中畢業前，美國自由車聯合會的青年國家隊已招募他了。	10. He finishes the revision of his first sentence translation. (He replaces his translations with MT outputs, as shown by the words in yellow and underlined.)

As shown in Step 3 in Table 5.13, Rory's translation made by HT had problems in vocabulary and grammar. He did not translate the place word 'Plano', and the words he chose (as highlighted in yellow) were not suitable in terms of situational appropriateness [21] (i.e., appropriate use of words for the context). For example, this word in the HT text '*騎單車者, qidanchezhe*' refers to people who ride a bike, while the word provided by MT '*自行車手, zixingcheshou*' refers to cycling professionals. In terms of grammar, the sentence in HT as indicated by the underlined text was too long and complex for easy understanding. However, MT used a relative clause '*是…的車手, shi…de cheshou, a cyclist who…*' to separate the long sentence into two sentences and to make the meaning clearer, although the second part of the MT sentence was inaccurate in sentence structure. To further complicate matters, the sentence in HT '*所有獎牌取消了, suoyou jiangpai quxiao le, all medals cancelled*' was grammatically

[21] In accordance with the rubrics for translation assessment in Chapter 4, the category 'situational appropriateness' refers to pragmatic competence. This includes making appropriate phrasing, word choice, and collocation in terms of sociocultural references, discourse, and register.

inaccurate and needed to be changed to a passive voice sentence '*被取消所有獎牌, bei quxiao suoyou jiangpai, all medals were cancelled*'. MT translated this sentence into '他*被剝奪了所有冠軍頭銜, ta bei boduo le suoyou guanjun touxian, he was stripped of all champion titles*'.

By comparing his HT and MT output, Rory revised his own translation based on the MT output. Before making changes to his translation, however, Rory employed MT and Google Search to look up the meaning of the MT output and double-check its accuracy, as shown in Steps 4 to 9. Following MT evaluation, he then revised his HT output as shown by the highlighted and underlined text in Step 10. This example shows that Rory uses MT with caution and double-checks MT output before accepting its translation. In addition, Rory's revised translation shows improvement in terms of situational appropriateness (i.e., appropriate use of words for the context), and grammar and mechanics (i.e., writing conventions). The scoring data are presented and discussed in Section 5.2.

Rory's strategy for using MT output in Chinese to check and revise his own Chinese translation has similarity to Amanda's strategy for using MT to check and revise her Chinese writing assignments:

> If I feel uncertain about a part of my written work, I will use MT to write English first to get a Chinese translation and then compare my Chinese texts with the MT Chinese translation. If I think the translation of MT is better, I will then revise the sentences I originally wrote [Amanda, interview].

When Amanda is not confident with her Chinese writing or not sure about the accuracy of her meaning expression in Chinese, she will compare her own Chinese writing with the Chinese translation produced by MT to help with revisions. This way of using MT is the same as her use of MT output in English to check her HT English output in the translation task (see Table 5.7), although adopting MT output in L1 English to check against HT output in L1 may focus more on checking the accuracy of L2 reading comprehension, as discussed in Section 5.1.2.2. Moreover, Lisa explained that she uses MT to translate her Chinese writing back to English to see whether her writing corresponds to her intended meaning:

> Sometimes, when I finish a speech draft or an essay, I will put it in the MT to check if the meaning is similar to what I want to express and make a comparison between English and Chinese [Lisa, interview].

Thus, Lisa refers to MT English output to check the accuracy of her meaning making in Chinese. Lisa's strategy is to directly check her meaning making and meaning expression in

Chinese. This differs from the strategies of Rory and Amanda, in which they use MT to translate their meaning making from English to Chinese to compare their own Chinese output with MT Chinese output for making revisions, particularly in word choice, word usage, and grammar.

Reponses to the closed-ended question 'How frequently do you use MT for checking what you wrote in Chinese?' reveal that three students (Rory, Lisa, and Amanda) showed an increase in the frequency of using MT to check their Chinese writing between the times of the pre- and post-intervention questionnaires (see Appendix 5.1). This suggests that the three students may find it beneficial to use MT to check and compare their Chinese writing and to assist with revisions after the intervention.

Helping with conveying intended meaning and expressing ideas in Chinese writing

Rory stated that, to assist their Chinese writing assignments, some fellow students use MT to write their thoughts in English to obtain a MT Chinese text as a draft which they follow by PE:

> I also heard that some students would write an English sentence or paragraph first. If they don't know how to express themselves in Chinese, they would write in English and put it in the MT to get a Chinese translation, followed by post-editing [Rory, interview].

Although Rory did not say he applied MT+PE in his own Chinese writing, he indicated that other students utilised it to sort out their problems in conveying meaning in Chinese. Similarly, Lisa, for example, employed MT+PE when having trouble making a transfer of meaning from English to Chinese. Figure 5.10 shows Lisa obtaining a raw MT Chinese output from Google Translate when having difficulties translating the English source sentence in Text 4. According to the screen recordings, she edited the MT output, together with the use of Pleco, into '*第四個人瞪著對面路綫的地圖 (disigeren dengzhe duimian luxian de ditu, the fourth person stares at the map of the line opposite)*'.



Figure 5.10 Screenshots of Lisa using MT to get raw Chinese output for PE

Based on the meaning of the source text, Lisa edited the inaccurate MT output '*四分之一 (sifenzhiyi, one fourth)*' to '*第四个人 (disigeren, the fourth person)*' and '*画着的线的地图 (huazhe de xian de ditu, map with drawn lines)*' to '*路綫的地圖* (*luxian de ditu, route map*)'. Although she did not translate the word 'framed' and the phrase '*路綫的地圖* (*luxian de ditu, route map*)' should have been changed to '*路綫圖* (*luxiantu, route map*)' in the PE version, Lisa produced a Chinese translation that was close to the meaning of the source text, with the aid of MT. This example shows Lisa drawing on her language capabilities in English and Chinese (possibly with L1 Dutch in her mind) to modify MT Chinese output to finish conveying the sentence meaning in Chinese.

5.1.2.4 Using MT as a resource to cross-check and evaluate MT output

Having seen that the students use MT to assist comprehension and production, it follows that evaluating the accuracy of MT seems important to them. As such, their next purposeful use of MT is to cross-check and evaluate MT output. The screen recording data in Section 5.1.1 show that when the students used MT, they would habitually double-check the MT output. In other words, they do not believe MT to be error-free, so they use it with caution. This is supported and explained by the remarks of students:

> I always use PEMT [MT+PE] when I use machine translation because I don't trust it to be 100% accurate [Amanda, questionnaire].

> I think PEMT [MT+PE] is always necessary, since MT tools still don't give the most accurate translations [Lisa, questionnaire].

Amanda and Lisa believe post-editing (PE) to be essential when consulting MT. All four students agreed with the proposition in the closed-ended item in the post-intervention questionnaire: 'I always do post-editing or proofreading when I use MT' (see Appendix 5.1). Two strategies were identified in relation to how students evaluated MT output to increase their translation accuracy. These were: 1) pre-editing of MT input; and 2) using more than one MT tool and additional online resources.

Pre-editing of MT input

The screen recording data demonstrated that when Amanda noted an inaccurate MT Chinese output, she pre-edited the source text (i.e., pre-editing of MT input) to make it clear in meaning. As shown in Figure 5.11, Amanda obtained an incorrect Chinese output '*一抽 (yichou, a draw)*' from Google Translate, so she subsequently added the word 'person' to the source text (MT

input) to make it transparent in meaning. She then received a more accurate MT output '*一個人抽煙 (yigeren chouyan, one person smokes)*'.

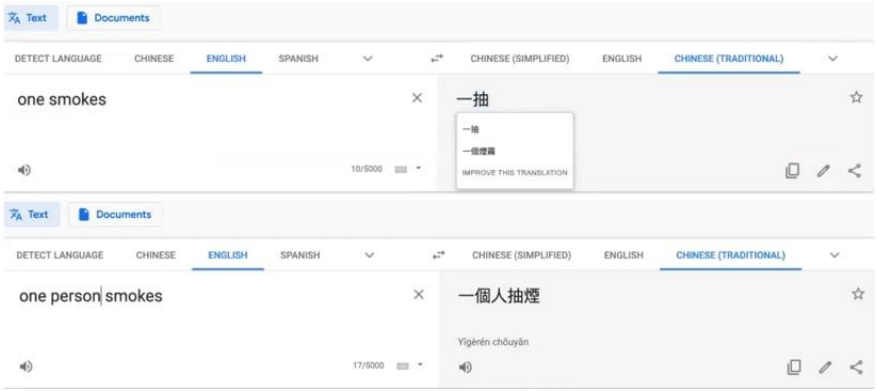


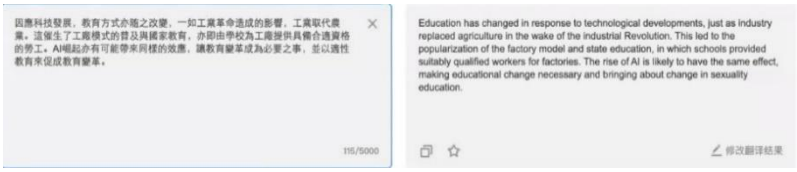
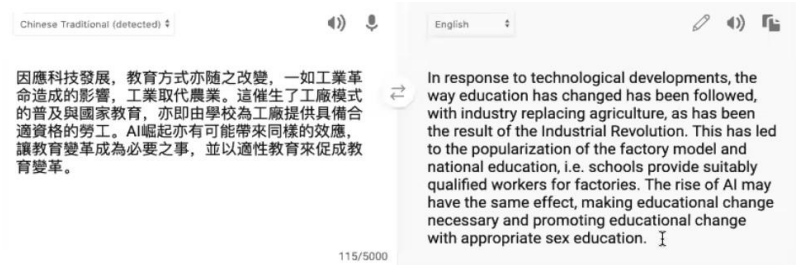
Figure 5.11 Screenshots of Amanda pre-editing of MT input to improve MT output

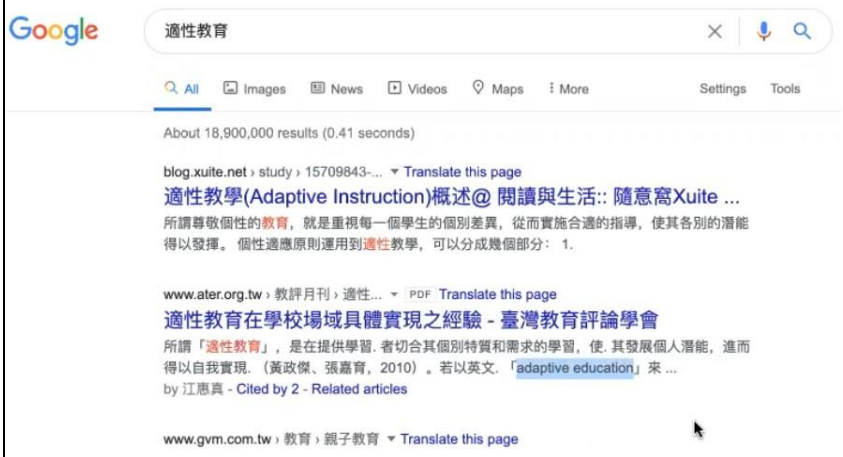
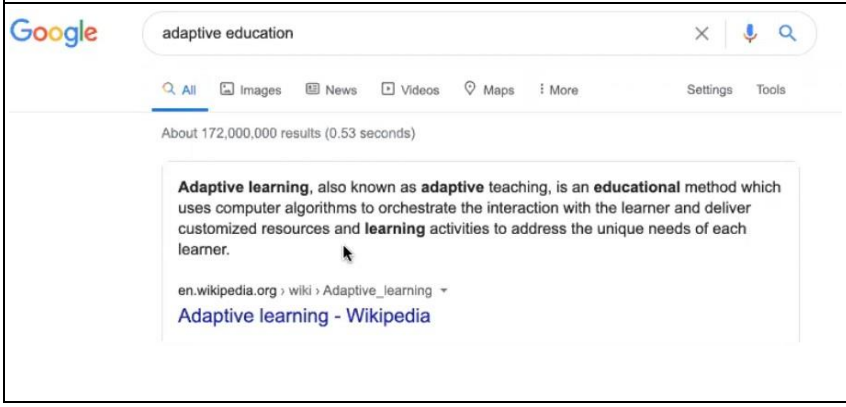
This example shows that Amanda applied the strategy of pre-editing MT input by editing the source text into a semantically clearer sentence to increase MT output accuracy. This finding suggests that pre-editing of MT input requires semantic and syntactic analysis capabilities in both languages so as to edit the MT input and judge the accuracy of MT output.

Using more than one MT tool and additional online resources

According to screen recordings, Rory, Lisa, and Amanda used Google Translate and additional resources such as dictionaries and Google Search to help with translation in the pre-intervention task; however, they changed their approach in the post-intervention task to adopt more than one MT tool together with their commonly used resources to complete translations. As indicated in Table 5.11, Rory referred to the English output of Google Translate to check his understanding of Chinese source text in the pre-intervention task. By so doing, he improved his comprehension of the Chinese text; however, his Chinese to English translation of the text was not fully accurate in terms of the source text meaning. This might be that because Rory consulted only Google Translate, he could only refer to MT output from this tool. The use of a second or third MT tool might have offered increased opportunities for accuracy. In the post-intervention task, Rory adopted the use of multiple MT tools (see Table 5.14).

Table 5.14 Screenshots of Rory using multiple MT tools for MT+PE from C to E

Screenshots	Commentary
 A  B  C  D	1. Rory obtains different paragraph translations in English from four MT tools: A) Baidu B) Youdao C) Google D) Microsoft
 	2. He chooses Baidu output as a draft and puts it on the task sheet. (He seems dissatified with his choice.)
 	3. He changes to use Microsoft output as a draft. (He still seems dissatified with this MT text.)

Source texts 1. 人工智慧 因應科技發展，教育方式亦隨之改變，一如工業革命造成的影響，工業取代農業。這催生了工廠模式的普及與國家教育，亦即由學校為工廠提供具備合適資格的勞工。AI 崛起亦有可能帶來同樣的效應，讓教育變革成為必要之事，並以適性教育來促成教育變革。 Adapt from The Economist: https://www.cw.com.tw/article/article.action?id=5082553 Translations (Target texts) Education has changed in response to technological developments, just as industry replaced agriculture in the wake of the industrial Revolution. This led to the popularization of the factory model and state education, in which schools provided suitably qualified workers for factories. The rise of AI is likely to have the same effect, making educational change necessary and bringing about change in sexuality education.	4. He selects Youdao output as a draft to do PE.
Source texts 1. 人工智慧 因應科技發展，教育方式亦隨之改變，一如工業革命造成的影響，工業取代農業。這催生了工廠模式的普及與國家教育，亦即由學校為工廠提供具備合適資格的勞工。AI 崛起亦有可能帶來同樣的效應，讓教育變革成為必要之事，並以適性教育來促成教育變革。 Adapt from The Economist: https://www.cw.com.tw/article/article.action?id=5082553 Translations (Target texts) Education methods change in response to technological development, such when industry replaced agriculture in the wake of the Industrial Revolution. This led to the popularization of the factory model and state education, in which the role of schools was provide suitably qualified workers for factories. The rise of AI is likely to have a similar effect, making educational change an unavoidable necessity, and bringing about	5. He post-edits the Youdao text and gets stuck on this Chinese term '*適性教育*, adaptive teaching/learning'. He refers to the translations produced by the other three MT tools.
	6. He uses Google search to look for information about this term and finds an English translation.
	7. He looks for the meaning of this English translation using Google Search.

Source texts	Translations (Target texts)	
1. 人工智慧 因應科技發展，教育方式亦隨之改變，一如工業革命造成的影響，工業取代農業。這催生了工廠模式的普及與國家教育，亦即由學校為工廠提供具備合適資格的勞工。AI 崛起亦有可能帶來同樣的效應，讓教育變革成為必要之事，並以適性教育來促成教育變革。 Adapt from The Economist: https://www.cw.com.tw/article/article.action?id=5082553	Education methods change in response to technological development, such when industry replaced agriculture in the wake of the Industrial Revolution. This led to the popularization of the factory model and state education, in which the role of schools was provide suitably qualified workers for factories. The rise of AI is likely to have a similar effect, making educational change an unavoidable necessity, with 'adaptive learning' driving education reform.	8. He translates the Chinese term into 'adaptive learning'.

As shown in Table 5.14, Rory skimmed through the translation provided by the four MT tools and then selected what in his view was the best MT version to use as a draft to perform PE. In this text, he initially chose Baidu output but soon after changed to Microsoft translation. Still not satisfied, he eventually selected the Youdao text as a draft to engage in PE. When coming to this Chinese term '*適性教育 (shiyingjiaoyu, adaptive teaching/learning)*', Rory referred to the output of the other three MT tools. He also used Google Search to understand this Chinese term and find an English correspondence.

Analysis of Rory's PE process and his final translation result indicates that employing multiple MT tools to cross-check MT outputs together with the consultation of additional online resources seems to help him better understand the Chinese source text. This subsequently helps him render an adequate English translation.

Similarly, when Amanda adopted more than one MT tool to undertake PE from English to Chinese in the post-intervention task, she appeared to be better able to judge MT accuracy and render a more accurate translation. As shown in Table 5.8, Amanda used Google output as a draft to perform PE and cross-checked with Baidu output. This enabled her to make a more correct judgement of MT accuracy. For example, when coming to this English source sentence '*…he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward…',* Amanda carefully compared the translations from Google and Baidu as follows:

Google output:

他拒絕進入 USADA 的仲裁程序，該程序導致該機構宣布將從 1998 年 8 月起剝奪他的所有獎杯和獎項 (He refused to enter USADA's arbitration process. The arbitration process led the agency to announce that starting from August 1998, it would strip him of all his trophies and awards.)

Baidu output:

他拒絕參加 USADA 的仲裁程序，這導致該機構宣布，將剝奪他從 1998 年 8 月起的所有獎品和獎項 (He refused to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 onwards.)

Comparing the two MT texts, whereas Google mistranslated the source text in meaning, Baidu output was more accurate. When Amanda evaluated Google output and cross-checked it with Baidu output together with the pop-up dictionary, she identified the error in the Google translation and then edited it based on the translation offered by Baidu, as shown in Table 5.8 (Steps 13 to 15).

The examples of Rory's and Amanda's processes show that using more than one MT tool in combination with their frequently used online resources appears to help them judge the accuracy of MT output in either Chinese or English. Rory and Amanda believe it helpful to adopt different MT tools to cross-check MT output and to evaluate MT accuracy:

> I've learned…making comparisons of machine translations using multiple MT tools. If translations from MT tools are the same, the translation accuracy rate will be higher; but if MT tools translate differently, I will then pay more attention to the difference [Rory, interview].

> I definitely learned about how different machine translation software differ from each other (before I thought that it didn't matter which one you used) [Amanda, questionnaire].

Based on these comments, the students have noticed that different MT tools might produce varied translations. Referring to different MT outputs pushes the students to focus on differences between them, which helps them spot potential MT inaccuracies and increase their translation precision. This then benefits the students in improving their Chinese to English translation (L2 Chinese reading comprehension) and English to Chinese translation (L2 Chinese writing production).

In addition to using more than one MT tool, the students adopt dictionaries (including MT as a dictionary) to look up words and to have a better understanding of word usage by looking at sample sentences, as shown by data in Section 5.1.2.1. They also utilise Google Search to double-check MT output, for example:

> …using Google search engine, for example, if I want to know the Chinese translation of 'green beans', I will use MT and then put the translation on Google Image to see if it is correct [Maggie, interview].

> I use Google News on Google search engine to check word collocations [Lisa, interview].
>
> …placing collocations provided by MT on the Google search engine to see if Chinese speakers would use this collocation or to see if that is a common collocation [Rory, interview].

In short, based on the multiple data sources, students' strategies to cross-check and evaluate MT output are: 1) using more than one MT tool to cross-check MT output of different language units; 2) using dictionaries to check word meaning and understand word usage by looking at sample sentences; and 3) employing the Google search engine to access Google Image for checking MT output and to look for word definitions, translations, and collocations.

5.1.2.5 Using MT as a resource to help maintain academic integrity

An important aspect of academic study is ensuring academic integrity, which is the source of the last purposeful use of MT identified in this study, namely to help maintain academic integrity. Focus group interview data suggest that students' perceptions of the relationship between using MT and academic integrity vary depending on their academic backgrounds. Table 5.15 shows the four students' academic backgrounds in their home countries based on pre-intervention questionnaires.

Table 5.15 Summary of students' academic backgrounds

Students	Academic backgrounds
Rory	Bachelor of Science
Lisa	Bachelor of Arts (in Chinese studies with a minor in Economics) Master of Arts (in Chinese studies with a minor in Economic Policy and Management)
Maggie	Bachelor of Science (in Biology with a minor in Chinese language)
Amanda	Bachelor of Arts (in Chinese studies)

Lisa and Amanda coming from academic language learning backgrounds consider that whether or not students will violate academic integrity is determined by how they use MT. Lisa argued in the interview, 'if you can only use MT to write an essay or article, then of course there are issues of academic integrity because it is not written by you'. This means that Lisa considers it to be improper if students use MT to produce an entire L2 written production without putting any effort into the linguistic output process such as PE. She further explained, '…if we directly use MT to complete writing, it is of course not learning'. In contrast, Lisa treats MT+PE as language learning, because it requires students' effort in editing the MT output therefore differing from simply using MT to produce entire assignments. When Lisa encounters

linguistic difficulties or what she calls ‘language problems’, she employs MT+PE as a strategy combination to solve problems, as shown in screen-recordings.

However, Rory coming from a non-language academic field of study argues that academic integrity is meant to prevent plagiarism, namely, to avoid using others’ ideas as one’s own, rather than whether MT is used or how MT is used:

> My understanding of academic integrity and plagiarism is that they refer to whether your written work comes from your own ideas, so I think this has nothing to do with what MT tools you use. Even if I completely use MT to translate my English writing into [L2] Chinese without undertaking PEMT [MT+PE], it cannot be viewed as plagiarism. I don’t use others’ words or ideas and then claim that it’s my own work. [Rory, interview].

In Rory’s opinion, academic integrity relates to the creation of original work or whether the work results from one’s own ideas, rather than whether MT is involved or whether MT+PE is applied: ‘I guess the professors of the science department wouldn’t care if I use translation technologies to write my research report’. Thus, with an academic background in science, Rory does not think using MT to translate assignments is problematic, even if MT is used to translate a whole work from L1 to L2.

Analyses of the comments by Lisa and Rory suggest that Lisa considers using MT to produce an entire language assignment as cheating, and treats MT+PE as an aid to help with L2 production, while Rory considers MT to be simply a tool to help translate one’s own ideas from L1 to L2. While they both believe MT to be beneficial to assist with written communication in the L2, they have different views on how it relates to academic integrity. Rory provided a clear explanation of his position:

> If they [students] know how to do PEMT [MT+PE], it would reduce the motivation for cheating, right? Because they don’t need to do so, they could write in their native language and then use PEMT [MT+PE] [Rory, interview].

According to Rory’s idea, when students are able to express themselves clearly and convey their own thoughts effectively with the use of MT+PE, they are less likely to clandestinely take the work of others as if that were their own (plagiarism). This seems to be in line with Amanda’s opinion:

> Some people don’t like to use Google Translate because it’s not perfect. If they understand how to do PEMT [MT+PE] to make machine translation more accurate, it may motivate them not to plagiarise [Amanda, interview].

Amanda believes that capabilities in MT+PE can overcome the limitations of MT. If students learn how to use MT+PE, they may be able to improve MT output quality. This would subsequently help them produce more accurate L2 production, thus avoiding plagiarism. Lisa, who graduated with a master's degree in Chinese studies, also agrees that MT+PE may avoid plagiarism:

> According to my experience, plagiarism is hard to avoid. I would sometimes change some words. If you want to use someone's ideas in your research paper, you could use PEMT [MT+PE] to make changes while keeping the same meaning…I found it useful [Lisa, interview].

This indicates that Lisa had paraphrased source texts by replacing words in the source text with other words while maintaining the source text structure. However, she found it challenging to paraphrase appropriately in the L2 to avoid plagiarism, as she said, 'plagiarism is hard to avoid'. Her strategy as a multilingual speaker, therefore, was to use MT+PE to facilitate paraphrasing, as she found this to be beneficial in her academic writing.

5.1.3 MT and PE capabilities

Based on the findings in relation to RQ 1 (How do multilingual learners use MT to support their L2 learning?), five purposeful uses of MT have been identified among the participating advanced L2 Chinese language students. Their first purposeful use of MT is typically as a multilingual dictionary. The students adopt MT to look for meanings and translations of words or phrases and to understand the usage of words or phrases by referring to sample sentences. Moreover, students use MT as more than a dictionary attending to word and phrase meanings; a second purposeful use of MT is to support L2 reading comprehension across larger units of language. The students utilise MT to speed up reading to search for reading materials for more in-depth reading, and to check Chinese reading for improving comprehension. The third purposeful use of MT identified in this study is to support L2 written production. The students use MT+PE to facilitate translation and to help with conveying intended meaning in Chinese, and adopt MT to check Chinese writing and assist with revisions. They also use MT purposefully to cross-check and evaluate MT output. The students' strategies for evaluating MT output and increasing translation accuracy are: pre-editing of MT input and using more than one MT tool plus additional online resources. The last purposeful use of MT is mentioned to help maintain academic integrity, whereby students employ MT+PE to support academic writing in L2 Chinese, including paraphrasing to avoid potential plagiarism.

Based on the findings, these advanced students of Chinese adopt MT as a resource in different ways (e.g., translating a source text from L2 to L1) and for different purposes (e.g., for checking understanding of the text) to support their L2 comprehension and production. They exploit MT+PE as a strategy combination to facilitate translation, to convey their intended meaning, and to support paraphrasing in academic writing. When consulting MT, the students evaluate MT accuracy by referring to two or more MT tools and additional online resources, followed by PE when needed. MT and PE capabilities, therefore, entail expertise in using MT as a resource (incorporating other online-based tools such as dictionaries and search engines) and MT+PE as a strategy combination involving MT evaluation, MT modification, and skills in consulting tools, making decisions, and solving problems.

5.2 MT and PE capabilities to advance L2 Chinese learning

Findings in the data that respond to RQ2 are presented here. Five interrelated processes through which students improve their translation and L2 Chinese learning have emerged from the analysis of the translation sample scores in pre- and post-intervention tasks, focus group interviews, questionnaires, and follow-up email correspondence. The five interrelated processes are:

1) Increasing efficiency in reading

2) Improving accuracy in text comprehension and production

3) Enhancing understanding of grammar and vocabulary

4) Increasing confidence in language learning

5) Raising awareness of appropriate use of MT

These five interrelated processes appear to indicate that learning to use MT and PE offers promise not only for advancing L2 Chinese language learning but also for gaining access to learning content.

5.2.1 Increasing efficiency in reading

Questionnaire and interview data indicate that MT may advance access to content knowledge by increasing comprehension and efficiency in reading time and that together these may contribute to the process of learning L2 Chinese, which is discussed throughout Section 5.2. Lisa indicated in the post-intervention questionnaire, ‘it [MT] can help you understand a text quicker’; elaborating in the focus group interview, she said that using MT to read online

information ‘doesn’t take me much time’. Similarly, during the interview, Rory reported that when he uses MT to assist reading texts in Chinese online ‘I don’t need to spend much time translating’. Amanda concurred that translating with MT is ‘the most convenient and fastest’. These data suggest that MT allows the students to translate information and access information and knowledge time-efficiently.

5.2.2 Improving accuracy in L2 text comprehension and production

The data suggests that learning to use MT and PE may advance L2 Chinese learning and access to knowledge by enhancing accuracy in L2 reading comprehension and writing production. The scoring data of students’ translation samples in the pre- and post-intervention tasks were used to examine changes in the accuracy of students’ translation between both tasks. The pre- and post-tasks included two Chinese to English translations of Text 1 (magazine article) and Text 2 (idiomatic story) and two English to Chinese translations of Text 3 (biography) and Text 4 (short novel). As indicated in Chapter 4, two assessors (a translation expert and I) scored the translation samples according to Angelelli’s (2009) five-point-scale rubric. The assessment categories in the rubric are: source text meaning (comprehension), situational appropriateness (pragmatic competence), grammar and mechanics (linguistic competence), style and cohesion (textual competence), and translation skills (strategic competence). The component of situational appropriateness refers to the appropriate use of language in terms of sociocultural references, discourse, and register, including phrasing, word choice and collocation. The category of style and cohesion concerns the ability to create a translated text in terms of text genre and to make it coherent, while translation skills refer to the ability to use resources to overcome translation problems and demonstrate good translation quality.

5.2.2.1 MT and PE to increase L2 text comprehension

The capability of understanding Chinese source texts is a principal component in translation from Chinese (the L2) to English. The scoring data in Table 5.16 show the changes in students’ scores in the Chinese to English translation of Texts 1 and 2 between the pre- and post-intervention tasks. It needs to be noted that Maggie’s scores are excluded in this table as she did not use MT and PE for Chinese to English translation in either task.

Table 5.16 Scoring data of changes in students' scores in Texts 1 and 2 between pre- and post-intervention

Assessment category 5=max; 1=min			Source text meaning	Situational appropriate-ness	Grammar & mechanics	Style & cohesion	Translation skills	**Change of score per text per student**
Texts and pre-/post-tasks			Source text comprehension	Pragmatic competence	Linguistic competence	Textual competence	Strategic competence	
Rory	Text 1 Magazine article	Pre-task	3	4	4	4	3	
		Post-task	4	4	4	4	4	+2
	Text 2 Idiomatic story	Pre-task	4	4	4	4	4	
		Post-task	5	4	4	4	4	+1
Lisa	Text 1 Magazine article	Pre-task	4	4	4	4	4	
		Post-task	4	4	4	4	4	No change
	Text 2 Idiomatic story	Pre-task	3	3	3	3	3	
		Post-task	5	4	4	4	4	+6
Amanda	Text 1 Magazine article	Pre-task	4	4	4	4	4	
		Post-task	4	4	4	4	4	No change
	Text 2 Idiomatic story	Pre-task	4	5	5	5	4	+2 & -2 No overall change
		Post-task	5	4	4	5	5	
Change of score across each category			+5	0	0	+1	+3	

As indicated in Table 5.16, except in the case of Text 2 (idiomatic story) and Lisa (having Dutch-English-French-Chinese languages in her repertoires), students' scores in the pre-intervention task did not seem to change significantly in the post-intervention task. In terms of Text 1, Rory slightly increased his scores in the categories of source text meaning and translation skills, improving his overall score by two points. His scores, however, remained unchanged in the categories of situational appropriateness, grammar and mechanics, and style and cohesion. Lisa and Amanda's scores remained unchanged for Text 1. In terms of Text 2, Rory slightly increased his scores in source text meaning, raising his overall score by one point. Lisa showed improvement in each of the five categories, particularly in source text meaning, increasing her overall score by six points. Amanda slightly increased her scores in source text meaning and translation skills but decreased her scores in situational appropriateness and grammar and mechanics, showing no overall change in the score.

Compared with students' source text meaning in the pre-intervention task, the three students each improved their comprehension scores from 3 or 4 to 5 in the post-intervention task for Text 2. The data also show that when the three students gain an increase in the score for source text comprehension, their scores for translation skills also increase (Rory for Text 1; Lisa & Amanda for Text 2). This may indicate that source text comprehension relates to translation skills; specifically, the ability to improve source text understanding may relate to the ability to use resources to solve translation difficulties. When comparing the change of score across each category at the bottom of Table 5.16, the scores increased the most in source text comprehension, followed by translation skills, and style and cohesion. However, when comparing the three students' change in scores between the pre- and post-intervention tasks, only Lisa showed a significant improvement in Text 2. As an L1 Dutch speaker, Lisa seeks to understand the Chinese source text and then translate it into English, neither of which is her L1. In Text 2 of the post-intervention task, she not only increased source text comprehension and translation skills but also improved her use of English, in terms of situational appropriateness, grammar and mechanics, and style and cohesion. Lisa specified:

> I read the original text and the translations of different MT tools and try to choose the translation that I believe is the most accurate or suitable [Lisa, questionnaire].

Thus, Lisa carefully reads and compares the source text and its translations provided by various MT tools to make the most appropriate interpretation of the text. This process pushes her to think more carefully about the source text meaning, as indicated by her response to the open-ended question, 'In what ways do you think MT/PEMT (MT+PE) is helpful in advancing your Chinese reading capabilities':

> [It] makes me think more about the meaning of the text, since I have to consider different possible translations and choose the most accurate one, thus it gives me a deeper understanding of the original text [Lisa, questionnaire].

Accordingly, the strategy for comparing the source text with different MT outputs benefits Lisa in gaining a better understanding of the source text. She subsequently makes decisions across her linguistic repertoires to determine the most proximal meaning between the source and MT translated texts. This process helps increase her understanding of the source text.

Based on the scoring and questionnaire data, learning to use MT and PE seems to enable the students to improve source text comprehension in the translation from Chinese to English with Texts 1 and 2. However, MT and PE seem to have little influence on students' use of their L1 English, except for Lisa, who has English as an additional language. This result indicates that

MT and PE may advance L2 Chinese learning and help students gain access to knowledge of translating content by increasing accuracy in L2 text comprehension. In terms of the five assessment categories, Chinese source text comprehension is necessary when translating from Chinese to English to render an equivalent translation between source and target texts. When students have trouble understanding the source text in L2 Chinese, they are unlikely to be able to produce an English translation that is appropriate in terms of transfer of meaning, even if they perform well at English word, sentence, and textual levels.

5.2.2.2 MT and PE to improve L2 text production

Capability in the appropriate use of Chinese language is important for accurate or appropriate translation from English to Chinese (the L2). The scoring data in Table 5.17 show the changes in students' scores in the English to Chinese translation of Texts 3 and 4 between pre- and post-intervention tasks.

Table 5.17 Scoring data of changes in students' scores in Texts 3 and 4 between pre- and post-intervention

Assessment category 5=max; 1=min Texts and pre-/post-tasks			Source text meaning Source text comprehension	Situational appropriate-ness Pragmatic competence	Grammar & mechanics Linguistic competence	Style & cohesion Textual competence	Translation skills Strategic competence	**Change of score per text per student**
Rory	Text 3 Biography	Pre-task	4	3	3	3	3	
		Post-task	5	4	4	4	4	+5
	Text 4 Short novel	Pre-task	4	1	2	2	2	
		Post-task	4	3	4	3	3	+6
Lisa	Text 3 Biography	Pre-task HT&MT	4	2	2	3	3	
		Post-task	4	4	4	5	5	+8
	Text 4 Short novel	Pre-task	4	1	3	3	3	
		Post-task	4	3	4	3	3	+3
Maggie	Text 3 Biography	Pre-task	4	3	2	3	3	
		Post-task	4	3	3	4	3	+2
	Text 4 Short novel	Pre-task	3	2	3	2	2	
		Post-task	4	3	4	3	3	+5
	Text 3 Biography	Pre-task	4	3	4	4	4	

Amanda		Post-task	5	4	4	5	5	+4
	Text 4 Short novel	Pre-task	4	3	2	3	3	
		Post-task	4	3	4	3	3	+2
Change of score across each category			+3	+9	+10	+7	+6	

As shown in Table 5.17, the four students all showed increased scores between the pre- and post-tasks for Texts 3 and 4. In regard to Text 3, Rory showed slight improvement in each of the five categories, increasing his overall score by five points. Lisa greatly improved her scores in the four categories apart from source text meaning, raising her overall score by eight points. Maggie showed slight improvement in grammar and mechanics, and style and cohesion, increasing her overall score by two points. Amanda slightly improved her scores in the four categories other than grammar and mechanics, increasing her overall score by four points. In regard to Text 4, Rory showed improvement in the four categories apart from source text meaning, raising his overall score by six points. Lisa improved her points in the categories of situational appropriateness and grammar and mechanics, increasing her overall score by three points. Maggie showed slight improvement in each of the five categories, increasing her overall score by five points. Amanda improved her scores in grammar and mechanics, raising her total score by two points.

Analyses of the scoring results indicate that the four students increase their scores to varying degrees. When comparing the change of score across each category at the bottom of the table, the scores increased the most in grammar and mechanics, followed by situational appropriateness, style and cohesion, translation skills, and source text meaning. In other words, the top three categories with the largest increase in students' English to Chinese translation scores after the intervention are grammar, appropriate use of language, and stylistic and cohesive use of the language.

A further finding is that Rory, Lisa, and Amanda gained higher scores than Maggie in the five categories for Text 3 (Biography). An explanation for this may be that whereas those three students used at least two MT tools to cross-check MT outputs, Maggie used only Google Translate, as indicated in Section 5.1.1. Nevertheless, all four students received the same scores in each of the five categories in Text 4 in the post-intervention task, although Rory, Lisa and Amanda used more than one MT tool, and Maggie only used one. Evidently the number of MT tools did not impact on the accuracy of the students' English to Chinese translation of Text 4

(short novel). This suggests that the number of MT tools used may have influence on the quality of non-literary (e.g., biography) translation in the L2 but not the quality of literary (e.g., short novel) translation in the L2. This might be because MT is more suitable for translating non-literary texts as indicated by previous research (e.g., Koponen, 2016; Shih, 2016, 2020b). However, using two or more MT tools to obtain MT output of non-literary texts may provide students with more accurate translations to work with, and therefore improve their final translation production.

In brief, learning to use MT and PE seems to enable the students to produce grammatically more accurate and contextually more appropriate translation in L2 Chinese. This suggests that the students are better able to convey the meaning of the English source text to Chinese readers with the aid of MT and PE. Translating from English to Chinese with MT and PE may help to improve the appropriate use of L2 Chinese, including vocabulary and grammar. This may subsequently enhance the overall accuracy and quality of L2 production, thereby enhancing Chinese language learning.

In the focus group interview Lisa stated, 'this course is helpful for my English and Chinese…after this course…I could translate faster and more accurately'. This shows that the teaching intervention helped Lisa as a multilingual person in learning both English and Chinese and understanding how to use MT and PE to improve her translation accuracy and efficiency. This is consistent with Amanda's interview comment, 'I have a better understanding of…how to make use of PEMT [MT+PE] to improve the accuracy of my translation'.

To sum up, the data from various sources reveal that learning and developing capabilities in MT and PE may help students improve accuracy in Chinese source text comprehension; furthermore, these capabilities may help students increase accuracy in using the Chinese language and rendering adequate text production. By improving accuracy in text comprehension and production, the students in this study appear to enhance their Chinese learning while acquiring knowledge of content.

5.2.3 Enhancing understanding of grammar and vocabulary

Learning to use MT and PE to improve accuracy in text comprehension and production may simultaneously enhance understanding of grammar and vocabulary, and therefore advance L2 Chinese learning. This is suggested by the following data:

> …when I could compare several different MT translations…I could gain a deeper understanding of specific meaning and logic of certain Chinese grammar [Rory, questionnaire].
>
> I think it is helpful when you analyze machine translations very carefully [Amanda, questionnaire].
>
> …we do post-editing…[we] consider and decide which word is the best, which means using MT to help learning [Lisa, interview].
>
> [I use Baidu] to gain a better understanding of vocabulary by seeing many examples of words in the context of sentences [Maggie, questionnaire].

Based on Rory's comment, comparing and evaluating the output of different MT tools helps him gain a better understanding of Chinese syntax, particularly the main meaning of some specific grammar. This aligns with Amanda's remark above, showing the usefulness of analysing MT output for language learning. The comments, on the other hand, indicate that MT and PE motivate students to consider and/or notice the relationship between semantics and syntax, especially when several different MT tools are involved. The students appear to recognise that even a nuanced change in syntax can lead to a significant change in meaning.

In addition to grammatical knowledge, Maggie and Lisa point out that MT and PE help them have a better understanding of Chinese vocabulary. As indicated by Lisa, they need to make decisions on word choice in context when using MT+PE. Prior to making decisions, they may need to consult tools, including but not limited to MT itself as a dictionary, to understand appropriate word usage, as Maggie said. This means students not only look up the meaning of words but also their relationship to other words (i.e., word collocation) to determine the most appropriate translation for the source text. In brief, according to the questionnaire and focus group interview data, the students appear to be able to enhance their understanding of Chinese grammar and vocabulary through the analysis of MT output when using MT and PE. This in turn may help expand Chinese language learning.

5.2.4 Increasing confidence in language learning

As discussed earlier, MT and PE, more precisely learning to use MT and PE, help the students increase efficiency in reading and improve accuracy in text comprehension and production. These in turn seem to help increase their confidence in Chinese language learning, as shown by two excerpts from the focus group interview:

Excerpt 1:

> Amanda: I think learning to use PEMT [MT+PE] can overcome my lack of Chinese capabilities.
>
> Maggie: I agree.

Excerpt 2:

> Li-Ching: Do you think MT is useful?
>
> Amanda: It's useful for my grades.
>
> Li-Ching: Is MT helpful for learning?
>
> Amanda: I am not sure. I just rely on technology.

The first excerpt reveals that Amanda and Maggie believe that understanding how to use MT and PE is helpful to increase their confidence when their L2 Chinese ability does not allow them to process difficult tasks in the target language. They view MT+PE as a strategy combination to overcome language barriers when linguistic problems arise. This confirms Lisa's remark in the focus group interview that MT helps her to gain 'a sense of safety' in completing Chinese assignments. Lisa feels more confident in producing her Chinese language tasks with the use of MT. These utterances justify further why Amanda and Lisa apply MT+PE as a strategy combination to solve translation or linguistic problems when they undertake HT and why Maggie changes her approach and uses MT+PE for the translation from English to Chinese, as shown by the screen recording data in Section 5.1.1. MT appears to increase students' confidence in their use of Chinese language, and learning to use MT and PE seems to not only increase their confidence but also enable them to overcome some challenges in language learning.

The second excerpt shows that MT helps Amanda increase confidence in gaining better scores. Amanda will continue to use MT, even though she is uncertain of its usefulness in language learning. Amanda's responses in the second excerpt suggest that language learners may consider that using MT technology as a means to increase opportunities for receiving good grades is as important as learning the target language. Analysis of the two excerpts of the student conversation indicates that language learners treat MT as a resource to help with input comprehension and output production, through which they seem to gain more confidence in language learning.

When responding to the closed-ended item, 'MT/PEMT (MT+PE) can increase confidence in writing course work', Rory and Lisa both showed a positive shift across the pre- and post-intervention questionnaires, from somewhat agree to agree and from disagree to agree, respectively (see Appendix 5.1). Amanda's response remained unchanged, being somewhat agree. Maggie somewhat agreed on this point in the post-intervention questionnaire but did not provide any answer in the pre-intervention questionnaire. Thus, two students (Rory and Lisa) find learning to use MT and PE can contribute towards increasing confidence in writing assignments, while the other two students (Amanda and Maggie) are a little ambivalent.

Taken together, the multiple data sources show that developing expertise in the use of MT and PE appears to help students increase confidence in language learning, because the capabilities in MT and PE seem to be able to narrow the gap between L1 and L2 and to improve their academic scores.

5.2.5 Raising awareness of appropriate use of MT

Learning to use MT and PE may advance L2 Chinese language and knowledge learning by raising awareness of appropriate use of MT. As indicated in the previous section, Amanda reported her use of MT to receive better scores in her Chinese assignments; however, numerical data from the questionnaires show that she changed her positive attitude to a negative attitude towards MT for language learning (see Appendix 5.1). When responding to the closed-ended item 'MT/PEMT (MT+PE) can strengthen my Chinese writing', Rory, Lisa and Maggie showed a positive shift of perception of MT and PE strengthening Chinese writing, while Amanda presented a negative shift. She clarified her change of opinion:

> I think relying on machine translation to complete assignments will have a negative effect on Chinese learning. I think information is retained better when you are actively doing the translating yourself [Amanda, questionnaire].

Amanda believes that human translation (HT) is more beneficial than relying on MT in terms of Chinese learning. Her comment, on the other hand, may indicate that if students do not depend on MT to complete assignments but employ it as a resource to support reading and writing, they may gain benefits from using MT. Amanda's change in opinion may also indicate that she became aware of her reliance on MT and found HT more useful for learning after the intervention. The student gave a further explanation for the changes in her view on MT in the follow-up email correspondence:

> I think what made me start to feel subconsciously negative about MT/PEMT [MT+PE] was that in the course, I could really compare MT/PEMT [MT+PE] with human translation in depth for the first time. I realized how much better doing human translation is at helping my Chinese ability and my translation skills to improve, even though oftentimes my human translations were not as accurate or didn't sound as good as the machine translations. Producing the language from my own brain or looking up words individually in the dictionary in human translation was what helped me improve my translation and language skills the most [Amanda].

The comment indicates that Amanda had usually used MT to translate large language units (e.g., sentences and paragraphs) to complete her Chinese writing assignments before the teaching intervention started. Numerical data from pre- and post-intervention questionnaires support this, showing that between the pre- and post-intervention questionnaire Amanda changed her frequency of using MT to translate large language units from almost always to sometimes (see Appendix 5.1). This student showed a reduction in the frequency of using MT to translate longer texts after the intervention, suggesting that it was not until this intervention that she found HT more beneficial for language learning because she could produce translation using her own Chinese knowledge, although she still used MT and PE when needed. This means that the teaching intervention helped this student recognise the importance of using MT and PE judiciously to support HT instead of overly relying on MT.

The other three students (Rory, Lisa and Maggie), however, indicated an increase in their frequency of using MT to translate sentences and/or paragraphs between the times of the pre- and post-intervention questionnaires. Rory acknowledged the benefits of learning MT and PE:

> …if this is a conventional translation course which doesn't focus on MT/PEMT [MT+PE], then I guess I would not feel it very helpful…my conclusion for translation (at least written translation) is that the most critical factor is translators' language proficiency in two languages [Rory, questionnaire].

For Rory, MT and PE seem to be more advantageous than only focusing on HT that mainly depends on the language capabilities of translators. This suggests that learning to use MT and PE to overcome difficulties in HT may be important for language learners as they might experience varying degrees of difficulty when using HT. However, judging MT accuracy is the key to the appropriate use of MT and also a first step prior to PE. When responding to the closed-ended item in the pre-intervention questionnaire, 'I know how to do post-editing of MT appropriately', Maggie did not answer and the other three students disagreed, although they indicated that they 'always do post-editing when using MT' (see Appendix 5.1). Nonetheless, each of the students changed their attitude and agreed with this statement in the post-intervention questionnaire. Following the teaching intervention they have come to understand

how to make appropriate use of MT and PE that best suits their own language learning and translation needs:

> I'd never thought of using multiple MT tools when translating, nor did I understand the limitations of MT. Now I have a better understanding of the chance of translation errors made by MT [Rory, interview].
>
> After this course, I know more translation methods so I can translate faster and more accurately. I know which method to use in which situation [Lisa, interview].
>
> I now better understand how to use MT and in what context I would like to use [Maggie, interview].
>
> I have a better understanding of how to process PEMT [MT+PE] and how to make use of PEMT [MT+PE] [Amanda, interview].

These comments reveal that the intervention enabled the students to have a better understanding of MT including its benefits and limitations, and how to use PE to improve MT output and their translation accuracy. More importantly, the students can decide in what context they want to use MT. The findings suggest that explicit teaching that involves HT, MT and PE may strengthen students' linguistic agency, enabling them to determine which translation method to choose for achieving which purpose and in what context. This reflects a relationship between student agency, context and strategic use in language learning (see also Gao, 2010). The findings also suggest that it might be necessary to prepare language learners with MT and PE capabilities, which may help them decide more effectively in what ways, for what purposes and in what contexts they can draw on their broader linguistic repertories for language and content knowledge learning.

5.3 Teacher-researcher reflection and reflexivity informing praxis

Upon reflecting on the findings after the intervention, I found that it had been valuable to engage language learners in the activities of HT, MT and PE. The findings also made me reflect that it might be even more beneficial for language learning if I focused on using HT, MT and PE as complementary strategies in my teaching practice. In other words, a reflexive response would include praxis that attends to the interrelatedness of HT, MT and PE in the translation process rather than viewing them as separate methods. This would mean that I should guide students to employ MT and PE to support HT in future teaching practice. I therefore made modifications to the planned teaching intervention for Student Group 2.

5.4 Chapter summary

This chapter has presented findings and preliminary analysis of the data from Student Group 1, four advanced students of Chinese in an L2 Chinese learning context. Regarding RQ1, the screen recording data have shown how the students use MT in their translation processes and the multiple data sources reveal students' five purposeful uses of MT and related strategies:

1) To look up words or phrases: The students use MT as a multilingual dictionary to look for meanings and translations of words or phrases and their usage.

2) To support reading comprehension: The students employ MT to speed up reading in order to search for Chinese learning materials while improving understanding, and to check their Chinese reading as a means of increasing comprehension.

3) To support written production: The students exploit MT to check Chinese writing and assist with revisions. They use MT+PE to facilitate translation and to help with conveying meaning and expressing ideas in Chinese writing.

4) To cross-check and evaluate MT output: The students perform pre-editing of MT input to increase MT output accuracy, and they use more than one MT tool together with additional online resources to evaluate MT accuracy.

5) To help maintain academic integrity: The students apply MT+PE to their L1 writing to assist L2 self-expression in their L2 writing, and they also employ MT+PE to facilitate paraphrasing for the purposes of academic integrity.

Analysis of how students use MT suggests that MT and PE capabilities entail expertise in using MT as a resource (incorporating additional resources such as dictionaries and search engines) and MT+PE as a strategy combination comprising MT evaluation, MT modification, and skills of consulting tools, making decisions and solving problems.

Regarding RQ2, the data from multiple sources show that learning to use MT and PE and developing MT and PE capabilities may advance L2 Chinese learning and also facilitate access to knowledge through five interrelated processes. These are:

1) Increasing efficiency in reading

2) Improving accuracy in L2 text comprehension and production

3) Enhancing understanding of vocabulary and grammar

4) Increasing confidence in language learning

5) Raising awareness of appropriate use of MT.

Through reflection-in-action (reflection during the intervention) and reflection-on-action (reflection after completion of the intervention) together with reflexivity, the findings prompted me to make changes to the planned teaching intervention for Student Group 2. The findings from Student Group 2 are presented in Chapter 6.

6 Chinese-speaking postgraduate students using MT and PE in EMI higher education: Findings

This chapter presents data, findings, and preliminary analysis from Student Group 2, the Chinese-speaking students studying postgraduate degrees in an English medium instruction (EMI) higher education institution (HEI). The participants include five master's degree students (Qing, Yun, Lian, Ying and Xiang) and one PhD student (Peng). Each research question (RQ) is addressed by analysing data from screen recordings of students demonstrating and explaining their MT use and subsequent tutorial discussions, focus group/individual interviews [22] (hereinafter referred to as interviews), questionnaires, and follow-up email correspondence. Regarding screen recorded data, screenshots were used to capture images to complement students' explanations of their MT use. Unlike the use of screenshots from Student Group 1 to show each student's translation processes in relation to advanced language learning, the use of screenshots from Student Group 2 is intended to focus on how students use MT for postgraduate study in an EMI context with particular attention to academic reading and writing.

Findings in relation to RQ1 (How do multilingual learners use MT to support their L2 learning?) are presented in Section 6.1. Discussed in this section are five purposeful uses of MT and related strategies generated from the multiple data sources regarding how the postgraduate students use MT. From an analysis of data on how the students use MT, the nature of MT and PE capabilities is revealed. Findings in relation to RQ2 (Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?) are shown in Section 6.2. Five interrelated processes emerging from the multiple datasets are discussed in this section to understand whether capabilities developed through learning to use MT and PE can advance L2 English learning.

[22] An individual interview was conducted with one student who could not join the focus group interview.

6.1 Students' purposeful use of MT in postgraduate EMI studies

Findings from the data that respond to RQ1 are presented and discussed here, demonstrating that the purposes for which students use MT influence the ways in which they use it. Five purposeful uses of MT as a resource along with related strategies emerge from the multiple data sources. These comprise students using MT:

1) To look up words or phrases (MT as a multilingual dictionary)

2) To support academic reading

3) To support academic writing

4) To help maintain academic integrity

5) To cross-check and evaluate MT output

As in Chapter 5, these uses are ordered in terms of the size of the language unit involved (from words and phrases to paragraphs, articles and student assignments), and in terms of language function, with reading comprehension preceding purposes related to written L2 production including academic integrity and MT output. Academic integrity has higher priority for extended academic writing for the postgraduate students than for SG1, therefore this purposeful use of MT is placed immediately after their MT use for supporting academic writing.

6.1.1 Using MT as a multilingual dictionary for words and phrases

In this study, the students' primary use of MT is to look up vocabulary and expressions for reading and writing tasks. They use MT as a dictionary to obtain word and phrase translations for understanding concepts in academic texts and for writing assignments. This is evident in the data below:

> MT can help me to translate words that I do not know in the process of reading and writing [Peng, questionnaire].
>
> …for some simple readings I would read by myself…and I resort to machine translation tools to translate words so I can get the meaning [Ying, interview].
>
> …using the translation machine [to] translate into English [from Chinese] …I find it's very useful… to assist my English expression [Qing, interview].

Both Peng and Ying reported that they adopt MT to look up meanings and translations of unknown vocabulary and terms to understand reading texts. In addition, the students use MT to search for suitable words and phrases to express themselves in English when they are writing

assignments, as indicated by Peng and Qing. Apart from this, they employ MT to look up the usage of words and phrases:

> I am using Baidu translator…checking the sample sentences…to check whether the usage of my phrase is correct or not [Peng, interview].
>
> …you can put [a phrase] in Youdao. Youdao gives you some sample sentences [Xiang, interview].

The two students, Peng and Xiang, use Baidu or Youdao to understand the usage of words and phrases by looking at sample sentences to check the accuracy and appropriateness of the words and phrases they are using. In other words, Peng and Xiang learn word and phrase usage by examining the sample sentences on the Baidu and Youdao tools. Nonetheless, Peng emphasises that he only refers to reliable sample sentences:

> …[checking] where these sentences are from. Are they from official websites that you can trust or are they just from Chinese websites that might not be reliable [Peng, interview].

To understand and exemplify what Peng meant, I used Baidu to look for sample sentences for the word 'reliably' and found that the sample sentences shown on Baidu came from different sources (see Figure 6.1).



Figure 6.1 Sample sentences on Baidu

Sample sentence 3 in Figure 6.1 is from the Oxford Advanced English-Chinese Dictionary, and Sample sentence 4 is from a website called 'dict.cnki.net'. According to the introduction to the website, this website is a platform that collects knowledge and information published online. The English sentence from this source, however, includes incorrect usage of words and grammar. This explains why Peng only refers to sentences from websites he trusts or knows – consulting known sources such as Oxford dictionaries is more likely to ensure the accuracy of sample sentences.

Responses to the closed-ended question[23] 'How frequently do you use MT for translating words?' in the pre- and post-intervention questionnaires (see Appendix 6.1) show that four out of six students (Qing, Yun, Ying and Xiang) increased their frequency of using MT to translate words. This means that more than half of the students use MT to assist with words more frequently after the intervention. Taken together, the open-ended and closed-ended questionnaire and interview data show that the students not only employ MT to look up the meaning and translation of words or phrases to understand reading texts and to complete writing assignments, but they also adopt MT (Baidu and Youdao) to understand the usage of words or phrases by looking at sample sentences.

6.1.2 Using MT as a resource to support academic reading

Following the use of MT to assist with words or phrases, the students' second purposeful use of MT is to translate larger language units (e.g., sentences and paragraphs) to help better understand academic texts in L2 English. Their strategies for supporting reading comprehension include using MT to 1) check comprehension of English reading; 2) translate large language units to help understand difficult texts; and 3) speed up reading to search for materials for more in-depth reading.

6.1.2.1 Checking comprehension of English reading texts

When the students are not sure whether their interpretation of academic texts is accurate, they use MT to check their understanding of what they have read, as indicated by Lian:

> It [MT] can be like a teacher who can help with your reading comprehension…when you read one paragraph, you think you understand it and you have your interpretation in your mind, and then you check it with MT and see if it's the same as your understanding [Lian, interview].

If she is not confident with her interpretation of the reading texts, Lian will adopt MT to translate texts from English to Chinese and then refer to the MT Chinese output to check her comprehension. This use of MT is similar to Ying's, who said in the interview, 'I will read [in English] first and then do the translation [using MT], do the comparison'. Ying's remark shows that her approach in using MT to check her reading comprehension is to 'compare' her understanding of the reading material with the Chinese translation obtained from MT. Lian and Ying both check that they accurately understand reading texts by comparing their own

[23] Responses to closed-ended questions in the pre- and post-intervention questionnaires are used only as supplementary data to support qualitative data.

interpretation with MT output. This suggests that comparing translations between HT (students' initial interpretation) and MT output when engaging in academic reading involves complex metacognitive activities. The students draw on their linguistic repertoires in at least two languages (English and Chinese) and MT to ensure a greater degree of accuracy in their reading comprehension.

When responding to the closed-ended question, 'How frequently do you use MT for checking what you read in English?' in the pre- and post-intervention questionnaires, three students (Qing, Yun, and Lian) reported increased frequency of MT use in this regard, although the other three students reported no changes to their occasional use of MT for this purpose (see Appendix 6.1). This result suggests that the intervention may have had pedagogical benefit for at least three of the six students. Reflecting on academic reading processes, it seems that ensuring a more accurate understanding of academic texts is especially important in terms of content knowledge acquisition, which in turn may influence subsequent academic writing. This is discussed further in Section 6.1.2.3.

6.1.2.2 Translating large language units to understand difficult texts

When the students encounter particularly challenging texts that are difficult to understand, they turn to MT to understand the reading texts, as shown in the data below:

> I will try to translate a whole paragraph [using MT] if I could not fully understand it [Peng, questionnaire].
>
> I use MT when I read an academic article with many terminologies and hard to understand [Xiang, questionnaire].
>
> …with many foreign words, really difficult to understand the sentences, I must use MT to understand it [Lian, interview].
>
> …for complicated readings, I read it through, but I still can't understand, I can't get the main points so I would…copy paste all the paragraphs…translate into Chinese…to know the main points of the paragraph [Ying, interview].

This shows that the students employ MT to translate large language units such as sentences and paragraphs from English to Chinese when the level of difficulty of reading materials exceeds their English reading capabilities and they can barely understand the meaning of the text. In such a case, they refer to the Chinese translation produced by MT to gain a general understanding. This strategy for using MT is not to check their comprehension, as it was in the previous section, but to understand the gist of the text. The above data also reveal that reading

complex academic texts is sometimes a problem for the students; reading with MT, however, seems to resolve their reading difficulties (at least in part).

Ying and Peng described their experiences of reading academic papers before and after the intervention:

> Before this tutorial, I would not think about [using] machine translation tools to do some translation. Even [if] I have difficulty in reading some papers, I chose to skip them. Now I could think about it [MT] when I am doing my assignment [Ying, interview].

> At previous stage of my PhD, I read some academic papers, but I actually couldn't understand the key points … So, I just skipped them because I didn't try to translate the whole paragraph [using MT] … I think it's a good strategy for me to translate a whole paragraph with the help of the machine translation tool [Peng, interview].

The comments of the two students indicate how reading difficulties had previously prevented them from understanding academic texts in English. Such difficulty is likely to hinder students from learning content knowledge and engaging in subsequent writing activities, such as paraphrasing or summarising information in academic texts as necessary for writing assignments or higher degree theses. Before the intervention, owing to reading difficulties and language barriers, they seem to have had no choice but to overlook complex texts they did not understand. However, the intervention appears to have helped the students to use MT to gain a basic understanding of challenging reading texts, followed by a more careful and detailed process of reading. This is illustrated in the next section.

6.1.2.3 Speeding up reading to search for materials for more in-depth reading

In addition to encountering difficult academic texts as discussed above, the volume of required academic reading and the investment of time required to digest this reading appears to be another problem for students. This is evident from the data below:

> Before this group, I never thought of using MT for reading. I just never finished it…because it's too much [Yun, interview].

> Before, I used English-Chinese dictionary to look up unknown words in reading, but sometimes I would forget what I read in the sentence after stopping reading to check unknown words. So, I have to go back to read a whole sentence or even a whole paragraph again [Qing, screen-recorded demonstration and explanation].

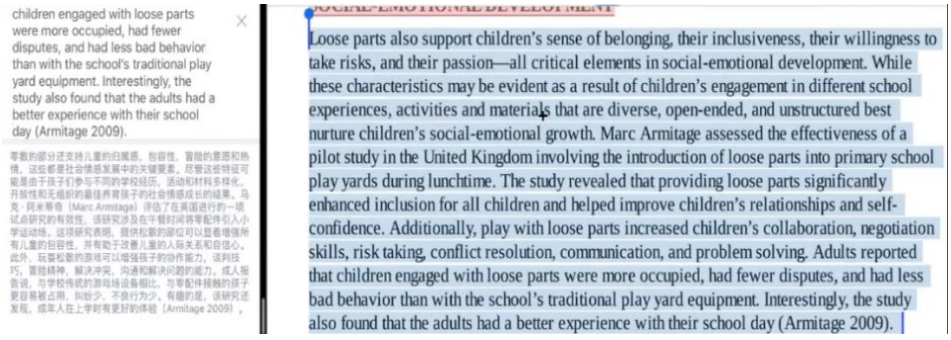
Here Yun and Qing share their previous experience in academic reading without using MT to translate paragraphs. A large volume of reading requirements used to prevent Yun from completing reading tasks. In the case of Qing, the need to interrupt reading to look up words

disrupted and prolonged the reading and comprehension processes. When asked how much time was required to finish a reading task, Qing explained:

> If I have three new words I don't know in a paragraph, I need to check [look up words] three times just for the vocabulary, and then I need to re-read the sentence at least three times. That's not include the situation that you forgot [what you read at] the beginning of the paragraph. If you forgot [what you have read], you need to go back again. So many times!! [Qing, screen-recorded demonstration and explanation].

From the start of the intervention, Qing began using MT to speed up reading in order to locate and evaluate materials for more in-depth reading. In the fifth tutorial Qing demonstrated how she used MT (Eudic) to carry out this process (see Table 6.1).

Table 6.1 Screenshots of Qing using MT (Eudic) to speed up reading for more in-depth reading

Screenshots	**Commentary**
	1. Qing translates the English text into Chinese using Eudic and quickly skim reads it. 2. She carefully reads the English text with the MT Chinese output.

As shown in Table 6.1, Qing's reading process with the use of MT comprised two steps. Step 1 (speeding up reading to locate materials) was to use MT to translate an English source text into Chinese and then to skim read this in Chinese to get a rough idea of the content, and to decide whether to use or reject the text for more in-depth reading. Qing explained that if she thought she might want to use the source text in a written assignment, she would proceed to Step 2. This second step (in-depth reading to evaluate materials) was to read the original English text alongside the Chinese translation produced by MT to gain a better understanding of the English content and evaluate its usefulness for her assignment (see Figure 6.2).

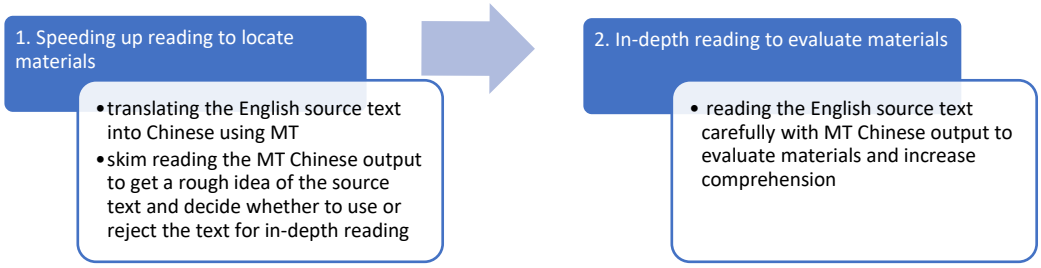


Figure 6.2 Qing's two-step process of using MT to speed up reading followed by in-depth reading

According to Qing, the purpose of skim reading the MT produced Chinese text at Step 1 is to search for and identify useful materials. The aim of in-depth reading in English with the MT Chinese output at Step 2 is to evaluate texts and to increase comprehension. Qing indicated in her demonstration, 'translation machine cannot translate meaning 100% accurately'; as a result, she must read back and forth between the source text and Chinese translation from MT. Thus, at Step 2 Qing would read the original English text conscientiously alongside the MT output in Chinese to obtain a better understanding of the content for her written assignments, as she later asserted:

> …if you really want to use some of the information in that reading, you need to re-read it, carefully read it in English… After that, I need to paraphrase the information and write it in my essays [Qing, interview].

This means the step of in-depth reading of the original English text is important, not only for improving understanding but also for paraphrasing the source text for academic writing. In addition, reading the source text in English thoroughly alongside the Chinese translation produced by MT appears helpful in terms of content knowledge learning. At the end of Qing's demonstration, half of the students (Lian, Peng and Xiang) agreed with Qing's reading strategy and considered this approach to be effective for academic reading:

> Peng: This strategy is very effective. I didn't translate the whole paragraph…I used translator tools to translate words. Qing's strategy is a little different from mine. I will give it a try.
>
> Lian: I don't use the same strategy as Qing, but I think Qing's strategy is worth trying.
>
> Xiang: I agree.

The conversation between the three students shows that Qing's two-step approach of using MT to speed up reading to search for materials followed by more detailed reading is seen as innovative and potentially effective for them. As such, Peng, Lian and Xiang appear willing to

try this strategy in their reading tasks. After the end of the intervention, Lian indicated that she now uses MT to look for useful academic papers for further study:

> …if I want to find some valuable papers for me to concentrate or do intensive reading, I need to save time, I need to do speed reading. But [reading] in English it's hard for us; [reading] in Chinese we can skim reading easily because we can understand the whole paragraph without reading every word or sentence [Lian, interview].

For Lian, reading in English is more difficult than reading in Chinese and requires more time; therefore, MT can be used for accelerating reading to select relevant literature from a large volume of academic papers. After identifying useful materials using MT, Lian will engage in 'intensive reading' with the source text once suitable materials are found, as demonstrated by Qing. This suggests that EMI students experience similar challenges in academic reading and that they can learn and exchange problem-solving strategies through a collaborative tutoring process. This finding also suggests that the collaborative teaching intervention offered a platform for reciprocal learning and knowledge exchange among students and between students and the teacher researcher.

6.1.3 Using MT as a resource to support academic writing

The students' third purposeful use of MT is to assist with academic writing in English. They use MT to translate larger language units to help produce more accurate and appropriate texts for assignments or thesis chapters in English. Their strategies for supporting writing production involve using MT 1) to clarify thoughts and express meaning in English; and 2) to check writing in English and assist with revision.

6.1.3.1 Clarifying thoughts and expressing meaning in English

When the students get stuck in their academic writing, they write in Chinese first and then translate to English using MT, as indicated by Qing:

> … sometimes I don't really know what I want to say, but by using translation machine, I need to clear my mind and see what I want to say…I need to input a Chinese sentence that is grammatically good or correct…this process has helped me to clear my mind and ideas…and then use the translation machine [to] translate into English and then I will do the post-editing. I find it's very useful… to assist my English expression as an international student [Qing, interview].

When Qing has difficulty in gathering her thoughts and how she is going to approach her writing, she begins by writing in Chinese to help clarify her mind and organise her ideas. She subsequently uses MT to process her Chinese text into English, followed by a process of PE. Figure 6.3 shows Qing's three-step process of using MT to clarify thoughts and express

meaning in English. Qing finds it helpful to express herself in English by following this sequence of steps.



Figure 6.3 Qing's three-step process of using MT to clarify thoughts and express meaning in English

Xiang, who adopts the same strategy, indicated in the interview that when using MT to translate the intended meaning from Chinese to English 'you don't need to struggle' with the difficulty of expressing ideas in English. This suggests that Xiang would rather consult MT to find a solution to express herself in English than feel like she is struggling. Interestingly, Qing advised that using MT in this way is sometimes more helpful to her than when she writes directly in English:

> …when I'm writing the essay in English, I just write it… it doesn't help me to clear my mind or organise what I want to say that much. It doesn't help. It just like I think of that, and I type it out. That's it [Qing, interview].

Qing's comment points to the role of L1 Chinese in developing ideas effectively. For Qing, writing in L2 English is not as beneficial as writing in L1 Chinese in terms of clarifying thoughts to express intended meaning. This indicates that the process of writing in L1 Chinese may differ from writing in L2 English. Thinking and writing in L1 Chinese allows the student to process at a deeper level of cognition that helps her develop and communicate ideas at a more substantive and academic level than if she were to write only in English. This may explain why the approach of writing in L1 and then translating to L2 seems to improve students' L2 writing and their confidence (Lee, 2018). Furthermore, when using MT to translate ideas written in L1 into L2, PE seems to be the key to producing an appropriate translation in L2 English:

> I do the post-editing…I need to post-edit the English sentence. After all the process, then I will use this sentence into my essay [Qing, interview].

Qing will evaluate and edit MT output in English prior to accepting the translation generated by MT. This quotation also shows that Qing adopts MT followed by PE (MT+PE) to solve problems in conveying her intended meaning in English, rather than using MT to produce an entire essay for her writing task.

Other students claimed that they usually write by themselves (HT) first and then use MT and PE to overcome difficulties or to check accuracy in their writing:

> I will use HT first, until I have some difficulties, I will use MT and PEMT [MT+PE] [Lian, interview].
>
> I will do that [HT] and double check by using MT and PEMT [MT+PE] [Yun, interview].
>
> I think I am the same [Peng, interview].

These comments reveal that only when difficulties arise in HT will these students adopt MT and PE as a solution. The data also indicate that the students value HT capabilities in terms of English learning, as Lian argued:

> … we need to have a balance between PEMT [MT+PE] and HT…if you want to improve English reading and writing, you need to find the balance. You can't be too dependent or rely on PEMT [MT+PE] [Lian, interview].

Lian appears to consider that both HT and MT+PE are important in English learning, and neither can be omitted or ignored. It is not the purpose of this study to measure the extent to which the intervention influenced students' perceptions of HT and MT+PE; however, the above interview data provide clear evidence that the students treat HT, MT and PE as complementary strategies for their academic learning and study, as emphasised in the intervention.

6.1.3.2 Checking writing in English and assisting with revision

When these students are not sure whether their English writing is accurate, they adopt MT to check their own written texts in English. This includes checking the accuracy of meaning making and grammar in their English writing, which helps them decide whether and how to make revisions.

Checking the accuracy of meaning making in English

The students utilise MT to check whether their English writing expresses their intended meaning. For example, Qing indicated that she adopts MT to check if her English writing expresses what she wants to say:

> [for] the difficult sentences, I think I express my ideas or my thinking very well, but I will just copy English one into a translation machine and let it translate into Chinese to see if it is correct …the translation machine is like [a] native speaker to check if my sentence could make sense to the native speaker [Qing, interview].

Qing uses MT to translate her English writing into Chinese followed by reading the Chinese translation to check whether her writing expresses her intended meaning. If the Chinese translation is equivalent to what she wants to express, then she can be confident that her English writing is accurate in terms of the expression of meaning. This way of using MT is similar to Lian's way, as Lian also refers to MT Chinese output to see if she has clearly conveyed her meaning in her English written work:

> I would firstly write down a paragraph in English and put it in the MT and check [if] the logic of translation [in Chinese] is correct [Lian, interview].

Thus, Qing and Lian check the accuracy of their meaning making in English by using MT to translate their English writing into Chinese and then reviewing the MT output in Chinese. This finding suggests that the students draw on their linguistic capabilities in both Chinese and English and MT to ensure greater accuracy in conveying meaning in their academic writing.

Checking the accuracy of grammar and assisting with revision

Some students employ MT to check grammatical accuracy in their English writing:

> I check my writing on MT and learn how to express my thoughts in correct grammar [Yun, interview].

> …it [MT] helps me check my grammar, maybe [the] basic subject-verb-agreement [Xiang, interview].

Together with checking the accuracy of their meaning making (previous section), the students compare their own English writing (HT output) with MT output to check the accuracy of their grammar. This seems to help them decide whether they should alter their English text and how to make revisions. In the fourth tutorial Yun used a paragraph of her own English writing to demonstrate how she used MT (Google Translate) to check the accuracy of meaning making and grammar, and to assist with revision (see Table 6.2).

Table 6.2 Screenshots of Yun using MT to check accuracy of meaning making and grammar in her English writing and assist with revision

Screenshots	Commentary	
Domestic violence and child protection are complex issues which involves different factors and need different actions to be resolved. Every client has different issues, the circumstances could be a combination of various complex causes, but the principles of our work will not be changed and the mindset will always be working with clients to achieve their goals and to empower the clients. 家庭暴力和兒童保護是複雜的問題，涉及不同的因素，需要採取不同的行動加以解決。每個客戶都有不同的問題，情況可能是各種複雜原因的組合，但是我們的工作原則不會改變，最認真的人將始終與客戶合作以實現他們的目標並賦予客戶權力。	own writing MT output	1. Yun translates her own English writing into Chinese using MT.
家庭暴力和兒童保護是複雜的議題，牽涉到不同的層面與原因，需要採取不同的行動加以解決。每個個案的狀況不一樣，個案的處境可能是各種複雜原因的組合，但是我們的工作原則不會改變，工作原則將始終是協助客戶實現他們的目標並賦權予個案。 Domestic violence and child protection are complex issues that involve different levels and causes. and require different actions to resolve them. The situation of each case is different. The situation of the case may be a combination of various complex reasons, but our working principle will not change. The working principle will always be to help clients achieve their goals and empower the case.	PE text	2. She post-edits MT and conveys her intended meaning in Chinese.
	MT output	3. She translates the post-edited Chinese text back to English using MT.
		4. She compares her own writing in Step 1 with MT output in Step 3 for making revisions.

As shown in Table 6.2, Yun went through a four-step process. At Step 1, she put her own English text into the MT to obtain MT Chinese output. The Chinese translation from MT allowed Yun to check whether her English text was equivalent to what she wanted to express. This MT Chinese output was not error-free as the word 'mindset' was translated as '*最認真的人 (zui renzhen de ren*, the most diligent people)' as indicated in the orange underlined text. At Step 2, therefore, Yun post-edited unsuitable MT output and conveyed her intended meaning. For example, she changed the Chinese translation '*涉及不同的因素(sheji butongde yinsu, involving different factors*)' to '*牽涉到不同的層面與原因*(*qianshe dao butongde cengmian yu yuanyin, involving different aspects and causes*)' so as to fully express her intended meaning. At Step 3, Yun translated the post-edited Chinese text back to English using MT to obtain MT English output. At Step 4, Yun compared her own written text with the MT English output produced at Step 3 for making revisions. By comparing the two texts, Yun identified grammatical inaccuracies in her own writing as indicated by the yellow underlined text in Table 6.2. Yun reported that she replaced the inaccuracies in her writing with the underlined MT

produced text at Step 3, although she did not show her final revised text in the demonstration. Figure 6.4 shows Yun's four-step process of using MT to check meaning making and grammar in English writing and to assist with revisions.

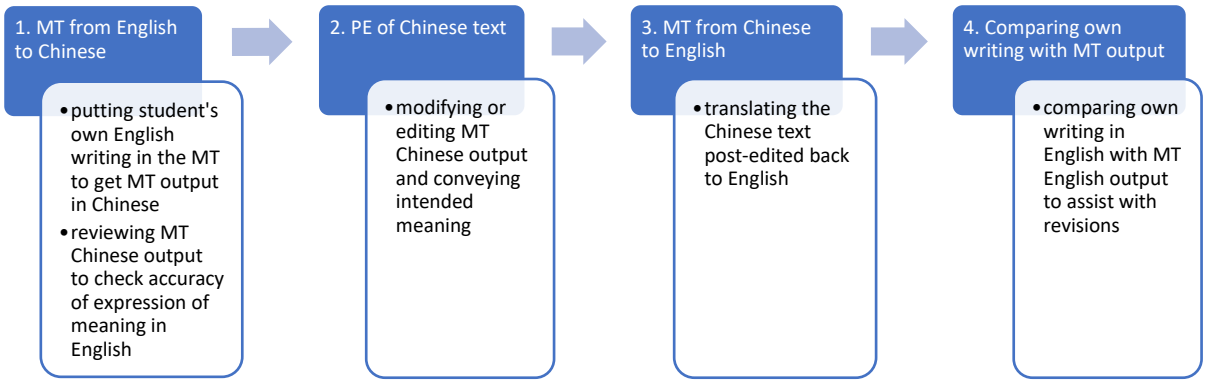


Figure 6.4 Yun's four-step process of using MT to check meaning making and grammar in English writing and assist with revision

Analysis of this example shows that MT mistranslates the Chinese words '*層面* (*cengmian, aspects*)' into 'levels' as indicated by the orange underlined text in Table 6.2, but Yun does not detect this MT error. This suggests significance in the role and capability of making effective judgements of MT output accuracy, which is discussed in Section 6.1.5. Despite the imperfect MT output, the four-step process seems to help Yun to convey her intended meaning, first through the PE step in Chinese, and then to identify her grammatical inaccuracies in English through the final step of comparing her own text with the MT text. Yun claimed these steps as beneficial for making revisions and improving grammar in her English writing:

> …usually, my professor has to correct my grammar errors, but for this one she didn't have to spend a lot of time correcting my grammar. So, I think that's good [Yun, screen recorded demonstration and explanation].

Comparison of responses in the pre- and post-intervention questionnaires to the closed-ended question, 'How frequently do you use MT for checking what you wrote in English?' (see Appendix 6.1) shows that five out of six students increased their frequency of using MT to check their English writing. Only one student (Ying) reduced her MT use in this regard from almost always to sometimes. Ying explained this in the follow-up email correspondence:

> The frequency for checking what I wrote in English and writing production are [is] decreased mainly because I am gradually being familiar with my course content…At first, I did not know [how] to make my essays academic, so I relied on translators quite often [Ying].

Thus, Ying's decreased use of MT to check her English writing is because she has become more familiar with her area of study and with academic writing in English over the course of her graduate study. This suggests that unfamiliarity with study content and academic use of English may be reasons that motivate a student to use MT more frequently. Nonetheless, the results from the other five students indicate that they find it helpful to use MT to check the accuracy of meaning making and grammar in their English writing and to help with revision, as demonstrated in the tutorial.

6.1.4 Using MT as a tool to help maintain academic integrity

In regard to how the use of MT relates to academic integrity, none of the students believe that using MT is associated with a breach of academic integrity. Instead, they consider that using MT does not matter because academic integrity is related to avoidance of plagiarism through the use of appropriate paraphrasing and referencing protocols when referring to and using the intellectual work of others. This view is evidenced below:

> …they [students] don't know what is paraphrasing and how to do paraphrasing. So, I guess there are a lot of misunderstanding of the paraphrasing process and academic integrity thing. So, those kinds of misunderstanding will… lead to plagiarism [Qing, interview].

> … as long as you know how to cite the resource [source] of information correctly. It doesn't matter whether you translate the information by using your own language knowledge or MT [Xiang, interview].

According to Qing, understanding how to paraphrase can avert plagiarism, while Xiang considers that understanding how to reference the sources of information used in academic writing is the key. Taken together, the two students' views are that academic integrity relates to understanding how to paraphrase and reference rather than whether or not MT is used.

Lian claimed in the interview, 'with that [MT] tool it's becoming easier to do paraphrasing…in that sense, it does help to maintain academic integrity'. Research shows that second language students find it challenging to paraphrase or summarise difficult academic texts as they need to have a substantial understanding of reading materials prior to rewording the reading texts (see for example, Hirvela & Du, 2013; Shi, 2012). Reflecting this, the students in this study used MT as an aid to support their academic reading and writing, as presented in the previous sections. They also used MT purposefully to assist in paraphrasing and/or summarising their reading to help maintain academic integrity. Their strategies in this regard involve using MT

to 1) reduce similarity between the source text and their paraphrased or summarised texts, and improving those texts; and 2) help with comprehension and paraphrasing.

6.1.4.1 Reducing similarity and improving paraphrased or summarised texts

Some students mentioned that they adopt MT+PE to improve their paraphrased or summarised texts, as Ying reported:

> I would write a paragraph by myself first, then if the similarity [to the source text] is high, I use machine translation tool to reduce the similarity [Ying, interview].

In other words, Ying adopts MT to reduce similarity between her paraphrased text and the source text, thus addressing academic integrity. When asked how she managed this process, Ying explained:

> [I] put English sentences [paraphrased] in the MT to get Chinese translations and then slightly adjust the Chinese translations and then translate back to English [Ying, interview].

Thus, Ying's strategy of using MT to reduce similarity between two texts is similar in nature to the use of MT to check one's own writing for making revisions, as Yun demonstrated in Section 6.1.3.2. That is, Yun and Ying utilise MT to translate their own English written texts into Chinese and then edit or modify the Chinese translation followed by translating back to English using MT. Specifically, the students improve their paraphrased or summarised texts in English by means of MT+PE.

The following data excerpt reveals Yun's use of HT, MT and PE to support summarising:

> I think one of the difficulties when I wrote my assignment is I want to paraphrase all these [papers] I have, but I don't know how to put them all together. And then I will try to do that in Chinese and then translate back [to English]. But I will definitely make some mistakes in grammar so PEMT [MT+PE] will help this, and I have found it really helpful in that scenario [Yun, interview].

Although Yun used the word 'paraphrase', what she actually does is to summarise several papers for her assignment. The student finds it challenging to summarise or synthesise the main ideas from different articles in English, so she uses HT, MT and PE. According to Yun's explanation above, the sequence of her summarising process is to 1) summarise in L1 Chinese; 2) translate the summary from L1 Chinese to L2 English by herself through HT; and 3) start the four-step procedure of using MT and PE (see Figure 6.4) to improve her summarised texts. When asked about MT use and academic integrity, Yun argued:

> …we don't just copy and paste…we still double check if that [MT output] is what we want to express and modify our own writing, hence it's still our own work [Yun, interview].

Together, the above data show that the students use MT+PE to reduce similarity to the source text (as Ying explained) and to improve their paraphrased or summarised texts (as Yun demonstrated). This way of using MT requires linguistic and cognitive effort to first evaluate and modify MT output and then make revisions of their own texts. In Yun's example, since the summary of articles was generated by the student because MT (at the time that this research was undertaken[24]) was unable to produce a summary for her, the student, therefore, asserted, 'it's still our own work'. Analysis of the students' strategies for using MT reveals the ethical use of this tool, in which MT is merely to make their paraphrased or summarised texts more appropriate while maintaining academic integrity.

6.1.4.2 Helping with comprehension and paraphrasing

The students introduced various scenarios in which the English source text was difficult for them to understand, let alone to paraphrase. In such cases, they use MT+PE to assist comprehension and paraphrasing, as indicated by Ying's response to the open-ended questionnaire item, 'Please write a few sentences or a paragraph to explain how you use PEMT (MT+PE)':

> If I come across some complicated sentences, I would use the machine translation tool to translate into Chinese first. Then I would modify some characters if I think the translation is not completely accurate. Next, I would translate the Chinese translation into English [using MT] …then still check the English translation accuracy and do some modifications [Ying, questionnaire].

Based on Ying's account, she adopts a six-step process. She first uses MT to translate complex sentences from English to Chinese. Second, she evaluates MT accuracy. Third, she modifies MT output in Chinese. Fourth, she uses MT to translate the modified MT Chinese output back into English. Fifth, she evaluates MT accuracy. Sixth, she modifies the MT output in English (see Figure 6.5).

[24] This study was conducted prior to the arrival of generative AI such as ChatGPT in late 2022.

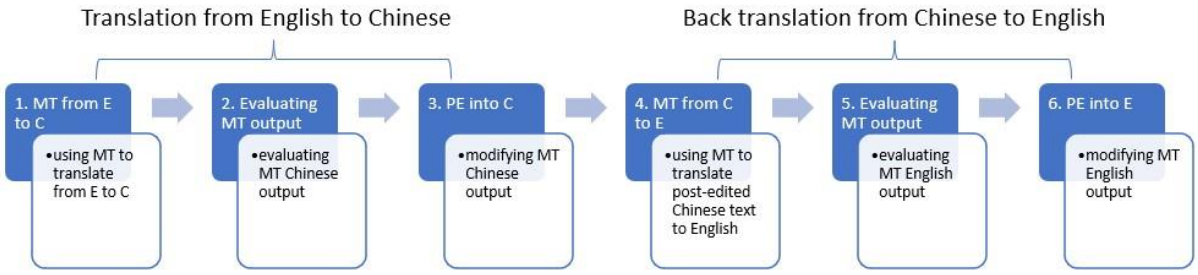


Figure 6.5 Ying's six-step process of using MT+PE for comprehension and paraphrasing

As shown in Figure 6.5, translation from English to Chinese seems to help Ying understand the challenging text in English, while back translation from Chinese to English appears to help her produce an adequately paraphrased text in English.

Lian also uses MT+PE to understand difficult texts and to complete paraphrasing in order to maintain academic integrity. In the fourth tutorial, Lian uses the sentence in Table 6.3 as an example to demonstrate her paraphrasing strategy with MT (Google Translate) when encountering difficult academic texts.

Table 6.3 Screenshots of Lian using MT+PE for comprehension and paraphrasing

Screenshots	Commentary	
原文 Original text: Chinese nationals are buying Australian vineyards and wineries at unprecedented levels, with up to 10 per cent of South Australia's iconic Barossa Valley now in Chinese hands. Google Translate: 中国国民正在以前所未有的水平购买澳大利亚的葡萄园和酿酒厂，现在中国人手中多达南澳大利亚标志性的巴罗莎山谷的 10%。 Post-editing of Google translation and Paraphrase in Chinese: 近年来，中国投资者对澳大利亚葡萄园的投资热情剧增，目前南澳大利亚的巴罗萨谷(Barossa Valley)有高达 10%的酒庄为中国人所有。 Google Translate: In recent years, Chinese investors' enthusiasm for investing in Australian vineyards has soared. At present, up to 10% of wineries in Barossa Valley in South Australia are owned by Chinese. Post-editing of Google translation: Chinese buyers' enthusiasm for investing in Australian vineyards has soared in recent years. Up to 10% of wineries in Barossa Valley in South Australia are currently owned by Chinese.	Source text	1. Lian translates the source text into Chinese using MT.
	MT output	2. She evaluates MT Chinese output.
	PE text	3. She post-edits and paraphrases the MT output in Chinese.
	MT output	4. She translates the post-edited text back to English.
		5. She evaluates MT English output.
	PE text	6. She post-edits the MT output in English.

As shown in Table 6.3, Lian went through a six-step process in search of high quality and accurate paraphrasing. At first, Lian used MT to translate the English source text into Chinese to get MT output in Chinese (Step 1). She then evaluated the Chinese translation (Step 2). This MT Chinese output sounded unnatural because of the phrasing and word order problem. For instance, the English phrase 'buying…at unprecedented levels' was translated into Chinese *'以前所未有的水平购买... (yi qiansuoweiyou de shuiping goumai..., using unprecedented level buying...)'* as marked in yellow. Therefore, Lian post-edited the Chinese translation and paraphrased the text in Chinese (Step 3). For example, she modified and reworded the underlined text into Chinese *'中国投资者对澳大利亚葡萄园的投资热情剧增 (zhongguo touzizhe dui aodaliya putaoyuan de touzi reqing juzeng, Chinese investors' enthusiasm for investing in Australian vineyards has surged)'*. Subsequently, she translated the post-edited and paraphrased Chinese text back to English using MT (Step 4). She then evaluated the English translation from MT (Step 5). Finally, she post-edited the MT English output to produce her perception of an appropriate translation (Step 6). Figure 6.6 shows Lian's six-step process of using MT+PE for comprehension and paraphrasing.

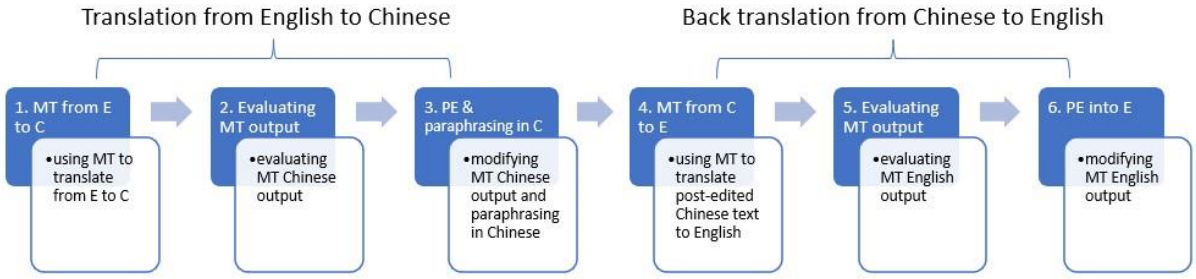


Figure 6.6 Lian's six-step process of using MT+PE for comprehension and paraphrasing

Analysis of Lian's paraphrasing process shows that PE and paraphrasing in Chinese at Step 3 seems essential to obtain a more appropriate translation at Step 4 and to avoid high similarity between the source text and paraphrased text. Also, PE at Step 6 appears important to produce a more accurate translation, even though the English translation produced by MT in this example was adequate in terms of source text meaning and the use of vocabulary and syntax. Although Lian indicated in the demonstration that this paraphrasing process is time-consuming as it involves engaging in translation activities twice, from English to Chinese and from Chinese to English, she considers it a viable strategy for paraphrasing difficult academic texts:

> …if you have no ideas on how to do that [paraphrasing], this is another option… because for us some English sentences are really hard to understand or even to paraphrase [Lian, screen-recorded demonstration and explanation].

This shows Lian's recognition that paraphrasing involves both reading comprehension and writing production, and that a better understanding of the text precedes paraphrasing. After seeing Lian's demonstration, Xiang agreed with this strategy, arguing:

> …it's easier for me to understand Chinese terminology than English terminology. So this applies to a lot of students who are learning professional [knowledge/subjects] through EMI. So maybe it's easier for them to use this method [Xiang, tutorial discussion].

Xiang believes the use of MT in this way to be beneficial for EMI students as it can overcome their difficulties in understanding and paraphrasing difficult academic texts. In fact, prior to participating in this study, she had herself shown other Chinese international students in the fields of Science, Technology, Engineering and Mathematics (STEM) how to paraphrase using MT. In the fifth tutorial of my intervention, Xiang demonstrated using MT for paraphrasing using the material she had used in her previous presentation prior to the intervention (see Table 6.4).

Table 6.4 Screenshots of Xiang using different MT tools for paraphrasing

Screenshots	Commentary
Original text: Diffuse pollution and waste sources make a major contribution to pollution loads in stormwater. Past legislation has concentrated on point sources of pollution such as specific industry exhaust stacks and discharge pipes, and has led to significant improvements in the management of hazardous wastes, wastewaters and air emissions throughout Australia. Point source improvements are still needed but present and future programmes must also target the diffuse sources. Google translation: Diffuse pollution and waste sources make a significant contribution to the pollution load of rainwater. Past legislation focused on point pollution sources, such as exhaust pipes and discharge pipes for specific industries, and led to significant improvements in the management of hazardous waste, wastewater and air emissions throughout Australia. Point sources still need to be improved, but current and future programs must also target decentralized sources. Baidu translation: Diffuse pollution and waste sources are the main sources of rainwater pollution load. Past legislation focused on point source pollution, such as specific industrial exhaust and discharge pipes, and led to significant improvements in the management of hazardous waste, wastewater, and air emissions across Australia. The point source still needs to be improved, but the current and future schemes must also target the diffusion source. Youdao translation: Diffuse pollution and waste sources are the main causes of heavy rain water pollution load. Past legislation has focused on point sources of pollution, such as specific industrial tailpipes and discharge pipes, and has significantly improved the management of hazardous waste, wastewater and air discharges throughout Australia. Point sources still need to be improved, but current and future programmes must also target decentralized sources. My version: Diffuse pollution and waste sources are the main sources of rainwater pollution load. Past legislation focused on point pollution sources, such as exhaust pipes and discharge pipes for specific industries, and has significantly improved the supervision of hazardous waste, wastewater and air discharges across Australia. Point sources still need to be improved, but current and future schemes must also aim at decentralized sources.	1. Xiang uses three MT tools (Google, Baidu and Youdao) to translate the English source text into Chinese and then directly translate back to English to get three versions of MT English output. 2. She marks the terms wanting to keep in yellow, while the words in red are marked to distinguish differences in word choice between the source text and MT output. 3. Xiang produces a paraphrased text by selecting the words, phrases, and sentence structures from the three MT outputs.

As shown in Table 6.4, Xiang first used three MT tools (Google, Baidu and Youdao) to obtain a translation from English to Chinese which was then directly translated back to English to provide three versions of MT English output (no Chinese translations were shown in this demonstration). Second, Xiang marked terminology that she wanted to keep in yellow and marked other words in red to distinguish the difference in word choice between the source text and MT output. Third, she produced a paraphrased text by selecting words, phrases, and sentence structures from the three MT outputs. According to Xiang, the text highlighted in grey in the rephrased version is a combination of translations from the three MT tools. Figure 6.7 shows Xiang's three-step process of using different MT tools for paraphrasing.

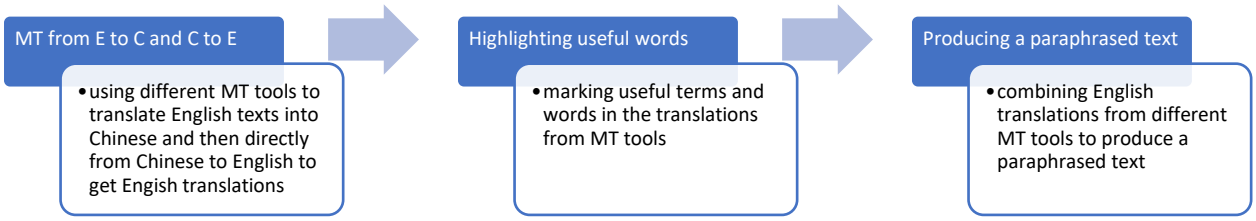


Figure 6.7 Xiang's three-step process of using different MT tools for paraphrasing

This example shows that Xiang obtained different translations from the three MT tools as points of reference, including the translations of words (e.g., major/significant/main), phrases (e.g., concentrated on/focused on), and sentence structures (e.g., …make a major contribution to…/…are the main sources of…/…are the main causes of…). She subsequently rewrote the original text by selecting her perception of suitable MT output and combining the translations together. Her paraphrased text, however, seems to have rather high similarity of sentence structure between the source text and rephrased text, as shown in Figure 6.7

In comparing the paraphrasing processes carried out by Ying (Figure 6.5), Lian (Figure 6.6) and Xiang (Figure 6.7), some differences are apparent. Ying and Lian evaluated and modified MT Chinese output at Steps 2 and 3 prior to translating back to English, however, Xiang omitted these two steps. More specifically, Lian not only post-edited MT Chinese output but also paraphrased in her own words in Chinese to reduce similarity between the source text and her paraphrased text. Analyses of the three students' paraphrasing processes suggest that the PE step and paraphrasing in Chinese may push students to better understand source texts; conversely, without this step, it may be difficult to ensure students' understanding of the reading materials. As Xiang stated in her demonstration, 'using this kind of method you don't

even need to know what you are reading'. This means Xiang can still produce a paraphrase that has relatively high similarity to the original text through using MT, even if she does not really understand the source text material. Xiang's use of MT for paraphrasing, therefore, may be interpreted as an academic integrity problem.

Peng and Qing indicated that PE and paraphrasing in one's own words are important in an appropriate paraphrasing process that maintains academic integrity:

> Post-editing really matters…to avoid plagiarism… they [MT outputs] are just materials… you have to paraphrase… based on the materials we have [Peng, interview].

> I don't think translation machines can help students to do the paraphrasing at all [Qing, interview].

The comments by Peng and Qing show that they recognise the importance of PE and paraphrasing in one's own words. In brief, the capability to use MT to translate difficult academic texts from English to Chinese followed by PE and paraphrasing in Chinese has significant potential for increasing and demonstrating students' understanding of the original source texts in English. Also, using MT to translate post-edited texts from Chinese back to English (back translation) followed by PE is an important process that helps students to increase accuracy and appropriateness in paraphrasing academic texts in English. This sequence of processes seems to help students avoid potential plagiarism and maintain academic integrity. It also demonstrates the ethical potential of using MT.

6.1.5 Using MT as a resource to cross-check and evaluate MT output

The final purposeful use of MT identified by in the student data is to cross-check and evaluate MT output to increase translation accuracy. The students do not seem to believe MT output to be precise, as Qing indicated:

> I need to do the post-editing, either from Chinese to English, or from English to Chinese, because that's machine, not our human brain [Qing, interview].

When consulting the MT tool, Qing will evaluate its accuracy and edit the translation produced by MT; this is because she considers that translations generated by MT are likely to be flawed. Human post-editing is therefore important to overcome the deficiencies of MT. The other students were also aware of the limitations of MT:

> …[translating] from Chinese to English…I think Google is better…from English into Chinese, I think Chinese company did better because Chinese is their language [Qing, interview].

> For me, now I still prefer using Youdao, but I think Google is sometimes more accurate [Lian, interview].
>
> Yesterday I used Google because something [went] wrong with my Youdao Translation. So, I used Google. I find it's maybe better than Youdao. I think the Chinese translation [from Google Translate] is more accurate [Ying, interview].
>
> I feel like Baidu and Youdao are doing better translating [to] Chinese than the other two [Google and Microsoft] [Peng, interview].

These comments show that, although opinions varied, two students (Qing and Peng) found that Chinese-based MT such as Baidu and Youdao worked better for English to Chinese translation, while US-based MT such as Google performed better for Chinese to English translation. This interesting finding may warrant further large-scale research that may be beneficial for students and other MT users who seek advice on which MT tool to choose depending on the directionality of translation (from English to Chinese, or Chinese to English). On the other hand, the variations in the interview data show that the students had personal views on MT output quality and their preferred MT tools to assist with translation from English to Chinese or vice versa, related perhaps to their fields of study. Although comparing the translation quality of different MT tools is beyond the scope of this current study, the data seem to support my preliminary finding before commencing the intervention, namely that different MT tools may complement one another and that, therefore, adopting two or more MT tools for cross-checking may help to judge MT accuracy. This was why I introduced four MT tools (Google, Microsoft, Baidu and Youdao) to the students in this study.

The students believe that English proficiency is the main determinant to make a correct judgement of the accuracy of MT output, as shown by the interview data, 'it really depends on the [MT] user's English level' [Qing] and 'it depends on our English level' [Lian]. Nevertheless, they proposed two strategies to evaluate MT output and increase translation accuracy: 1) using more than one MT tool and additional online resources; and 2) pre-editing of MT input.

6.1.5.1 Using more than one MT tool and additional online resources

The students' strategy for evaluating MT accuracy is to adopt more than one MT tool to cross-check MT output, as indicated by the interview data, 'to cross-check with other MTs' [Lian], 'use more than one MT software' [Ying], 'use more MTs instead of just one' [Xiang], and 'use different machine translation tools to check, to have a cross-check' [Peng]. These four students affirm their use of two or more MT tools for double-checking and evaluating translations produced by MT.

However, Yun explained in the interview that she uses only Google Translate, 'I don't read simple Chinese. I can't use other stuff, but I do like Google Translate'. Google Translate is the only MT tool Yun adopts because she uses traditional Chinese script and cannot read translation in simplified Chinese on Baidu and Youdao. Qing also prefers to use only one MT tool to translate all language units (e.g., words, sentences, and paragraphs), rather than jumping between various MT tools:

> I use Eudic to translate the paragraph. For some words, I really want to have a deep look at it, I just go into that app and check the words. So, it's easier for me, I don't need to change between the apps. [Qing, interview].

Qing employs MT (Eudic) to translate large language units as well as words for further understanding and double-checking word meaning.

Analyses of the interview data reveal that four out of six students in the study favour using more than one MT tool to cross-check and evaluate MT output. As argued earlier, different MT tools might complement one another. Double-checking between MT tools may help students assess MT accuracy. Moreover, making a judgement of MT accuracy by referring to different MT tools may encourage students to compare and think in more depth about different translations from various MT tools. This in turn may enhance students' metalinguistic skills (Gass, 2017). This is further discussed in the next chapter.

In addition to using MT to cross-check and evaluate MT output, students also adopt search engines to check MT accuracy, as indicated by Peng:

> I extract the phrase [translated by MT] I am unfamiliar with and then I will check whether this phrase is regularly used in academic articles or in machine translation tools. Maybe two ways to check it [Peng, interview].

Peng accesses search engines to look for academic articles to examine whether the terminology or phrase translated by MT is used in his area of study; he also uses other MT tools to double-check its suitability. In addition, students utilise search engines to check the accuracy of MT output, for example:

> …I type key words in Google to see the result [Peng, interview].

> We also use search engines to look for specific terms and phrases to see if people use the same terms or phrases [Lian, interview].

The comments show that Peng and Lian draw on search engines such as Google Search to check whether words or phrases translated by MT are appropriate or commonly used. In brief,

the students adopt more than one MT tool to cross-check and evaluate MT output, and use search engines to access academic papers to check the suitability of MT generated terms and to check the accuracy of MT produced words or phrases.

6.1.5.2 Pre-editing of MT input

Xiang reported that her strategy to increase MT output accuracy is to edit the source text (MT input) using unambiguous words and non-complex sentence structures:

> If I get a very strange [MT] result…I will look into the smaller parts of the original sentence in Chinese…see if there are some Chinese phrases that are too hard for machines to translate into English…After I have identified the hard part...I will change the Chinese phrases into easier Chinese expressions or sentences for machine to understand…until I get a more accurate translation in English [Xiang, questionnaire].

When Xiang detects any inaccuracy in MT English output, she will then examine the language units (from words to sentence structures) of the Chinese source text. Subsequently, she will edit the Chinese source text (MT input) to make it transparent, using simple words and sentence structures until she receives appropriate MT output in English.

Analysis of Xiang's strategy for pre-editing MT input to increase output accuracy shows the complexity of the (meta)cognitive and (meta)linguistic process involved. Xiang has drawn on her linguistic repertoire in Chinese and English to analyse MT input and output, particularly making input brief and clear enough to obtain a greater degree of accuracy in output. This requires her capabilities in both languages as well as the ability to analyse semantic and syntactic features of the two languages. Likewise, Lian mentioned in the interview that she will 'edit original texts to get more accurate translations [from MT]'.

Upon reflecting on this finding, I realised that pre-editing of MT input was not demonstrated or included in the tutorials, so there was no example in the data set to show how Xiang and Lian edited their original text to receive more precise MT output. The finding, however, indicates that the practice of pre-editing of MT input may offer additional value for MT-related teaching, and this warrants future research. It also suggests that students find ways to work with MT tools to best suit their purposes, and that effective use of MT requires experience and practice (see also Jia et al., 2019; Yang & Wang, 2019).

6.1.6 MT and PE capabilities

Based on the findings in relation to RQ 1 (How do multilingual learners use MT to support their L2 learning?), analysis has identified five purposeful uses of MT by the group of EMI

postgraduate students. The first purposeful use of MT is as a multilingual dictionary. The students adopt MT to look for meanings and translations of words or phrases and to understand their usage by referring to sample sentences. Moreover, they use MT as more than a dictionary; they use it to support academic reading in articles, book chapters and so forth. The students utilise MT to check their comprehension of L2 English reading texts, to translate large language units that are difficult texts to understand, and to speed up reading to search for materials for more in-depth reading. Their third purposeful use of MT is to support academic writing. The students use MT+PE to clarify thoughts and express meaning in English and to check writing and assist with revision. Another purposeful use of MT in students' written production is to help maintain academic integrity. The students employ MT+PE to reduce similarity and improve their paraphrased or summarised texts, and to help with comprehension and paraphrasing. A fifth purposeful use of MT is to cross-check and evaluate MT output. The students' strategies for evaluating MT output and increasing translation accuracy are: using more than one MT tool and also additional online resources, as well as, independently of the intervention, engaging in pre-editing of MT input.

Based on the findings, it can be concluded that these EMI postgraduate students adopt MT as a resource in different ways (e.g., translating own writing text from L2 to L1) for different purposes (e.g., for checking accuracy of own writing and assisting revision) to support their academic reading and writing. They exploit MT+PE as a strategy combination to facilitate academic writing including paraphrasing and/or summarising that requires both understanding of academic texts and rewriting content from what they have read into their own written text. Their strategic use of MT and PE enables them to address difficulties in completing their assignments or thesis chapters. According to the multiple data sources discussed earlier, MT and PE capabilities entail expertise in using MT as a resource (incorporating other online resources such as search engines) and MT+PE as a strategy combination involving MT evaluation, MT modification, and skills in consulting tools, making decisions, and solving problems. Taken together, MT and PE capabilities indicate the presence of an expanded multilingual repertoire that includes comparative thinking, cognitive skills, and evaluative and metalinguistic capabilities. This is discussed in detail in Chapter 7.

6.2 MT and PE capabilities to advance L2 English learning

Findings in the data that respond to RQ2 are presented here. In relation to how MT and PE capabilities advance L2 English learning, five interrelated processes by which students improve

their translation and L2 English learning have emerged through the analysis of multiple data sources. These processes are:

1) Increasing efficiency in reading
2) Improving accuracy in L2 text comprehension and production
3) Increasing opportunities for learning vocabulary and grammar
4) Increasing confidence in academic learning
5) Raising awareness of appropriate use of MT

These five interrelated processes appear to indicate that learning how to use MT and PE offers potential not only for advancing L2 English learning but also for learning content knowledge. This shows a parallel with the L2 Chinese student group (SG1), even though the student groups are in different settings.

6.2.1 Increasing efficiency in reading

Understanding how to use MT and PE may advance L2 English learning and facilitate access to content knowledge by increasing efficiency in academic reading. As Yun reported in the questionnaire, 'As a non-native English speaker, reading is very time consuming…Translate paragraph into Chinese to read is more efficient'. Qing's experience of reading academic articles in English, discussed in Section 6.1.2.3, supports Yun's comment. When they adopt MT to translate English texts into Chinese to read, the students can save time looking up unfamiliar words and terms, as explained by Qing:

> … [MT] saving my time to check the vocabulary, some terminologies that I don't know, because using the translation machine, it translates a paragraph…it also translates the vocabulary or the terminology [Qing, interview].

When using MT to translate large language units such as paragraphs, the paragraph translation generated by MT contains translations of smaller language units, including words, phrases, and sentences. This means the students do not need to stop reading to look up words, but they can read entire sentences and even a whole paragraph, for example:

> …if you want to comprehend a sentence, you must read it as a whole not just word by word, especially for a complicated sentence…Sometimes the meaning of each sentence connects together [Qing, screen recorded demonstration and explanation].

This indicates Qing's awareness that understanding the meaning of individual words in a sentence is not necessarily equal to understanding the sentence. The literal meaning of a word may be different from the meaning of the word combined with other words in a sentence (Angelelli, 2009). In the same vein, understanding a sentence does not guarantee understanding the key concept in a whole paragraph that may be comprised of several sentences. However, when reading with MT, students can read a large language unit as a whole and maintain a smooth reading flow. As Qing indicated in her demonstration (Table 6.1), 'using machine translation, I am like a native English speaker…I will directly know what the paragraph wants to say'. Clearly an aspiration for Qing is to be able to read and understand the content information in English as readily as an English L1 reader. To accomplish this, she makes use of MT because reading with MT allows her not only to speed up reading but also to increase comprehension of connected ideas.

Questionnaire data support this result, for example, 'it [MT] helps me absorb the context better' [Yun], and 'it [MT] can save me much time and I can grasp the basic meaning of some paragraphs' [Ying]. These two students believe that reading English academic articles with MT Chinese output can increase their understanding of the reading content while also accelerating reading. When responding in the post-intervention questionnaire to a closed-ended item 'MT/PEMT (MT+PE) can save time on course work', the six students agreed or strongly agreed (see Appendix 6.1). Specifically, Qing strongly agreed with this statement in the post-intervention questionnaire, although she did not give any answers in the pre-intervention questionnaire because she had never previously used MT. Two students (Yun and Peng) showed an increased positive attitude on this point between pre- and post-intervention questionnaires, while two other students (Lian and Ying) remained unchanged. One student (Xiang) slightly changed her attitude from strongly agree to agree. Xiang explained the cause of the change in her perception of this item in the follow-up email correspondence:

> [my] opinion was influenced by another participant's opinion which stated that performing MT and PEMT [MT+PE] is more time-consuming than we think [Xiang].

The numerical data after the intervention show that three of the six students (Qing, Yun and Peng) found that learning to use MT and PE could save time on their assignments, especially for reading tasks. Together, the multiple data sources reveal that the explicit tutoring on MT and PE appears to help students increase efficiency in English reading, including often (but not always) reading faster and understanding better. This may help to advance their content knowledge learning as well as English learning.

6.2.2 Improving accuracy in L2 text comprehension and production

Learning to use MT and PE may advance L2 English learning and facilitate access to content knowledge by improving accuracy in L2 reading comprehension and writing production. This is evidenced in the data presented in prior sections, showing that the students employ MT to improve their reading comprehension (Section 6.1.2) and MT+PE to solve their difficulties in academic writing (Sections 6.1.3 & 6.1.4). In terms of reading, MT seems to help the students increase accuracy of reading comprehension, which might contribute to learning of English and content knowledge. In terms of writing, Yun stated:

> **…** my professor…understands [my writing] better because I used to get some feedback like 'I don't understand' and now I don't get that anymore [Yun, interview].

This shows that understanding how to use MT and PE seems to help Yun complete written assignments more effectively and increase accuracy in her academic writing. As shown in Figure 6.4, Yun adopts MT as a resource to go through a four-step process to check the accuracy of meaning making and grammar in her English writing and to assist with revision. Yun's strategy for using MT allows her to convey the intended meaning, to spot unsuitable English expressions, and to detect grammatical inaccuracies in her original English writing. These skills enable Yun to revise her own English writing and increase the degree of accuracy in her assignments. Her writing has become more readable for the lecturer as a result of these efforts.

When responding to the closed-ended item 'MT/PEMT (MT+PE) can produce more accurate course work', five students agreed or strongly agreed, and one student somewhat agreed in the post-intervention questionnaire (see Appendix 6.1). Three of the six students (Yun, Peng, and Xiang) showed a more affirmative attitude between pre- and post-intervention questionnaires. Qing somewhat agreed with this point in the post-intervention questionnaire but had not given any answers in the pre-intervention questionnaire. The responses from two students (Lian and Ying) remained unchanged. Overall, the numerical results together with other data sources show that learning to use MT and PE may benefit students in increasing accuracy in their English reading and writing tasks. The processes of attempting to increase accuracy in academic reading and writing may help to advance both English learning and content knowledge learning as will be argued below.

6.2.3 Increasing opportunities for learning vocabulary and grammar

When the students attempt to utilise MT and PE to improve accuracy in text comprehension and production, they seem to learn vocabulary and grammar at the same time. Thus, reading academic texts in English along with MT output in Chinese may help students learn grammar while increasing understanding of the texts. This is illustrated in Ying's account of her habitual process:

> I would read the [MT translated] sentence in Chinese carefully and break down the English sentence. I break the structure of the English sentence, so I would get the meaning [Ying, interview].

Ying attempts to understand the reading material by unpacking the English sentence with the aid of MT Chinese output. She pays particular attention to sentence structure variations between the English source text and the MT produced text. Comparing the two texts seems to help her learn English grammar while understanding the reading material. This result is supported by Qing's comment:

> I found it's [MT] helping my reading and grammar as well, because sometimes with long sentences in English, it is very hard to figure out what is object, what is subject, what is the verb… I can learn the vocabulary quickly and then improve my grammar. You know, not the writing grammar but like the reading grammar [Qing, screen recorded demonstration and explanation].

In Qing's experience, reading with MT enables her to analyse and break down long sentences into small language units, such as subject, verb, and object. In so doing, Qing is learning English grammar and vocabulary while improving her comprehension of complex English sentences. This suggests that reading English texts side by side with Chinese translation produced by MT may be a potential tool to expand students' vocabulary and grammar in English. In terms of learning vocabulary, Qing offered a further explanation:

> …it [MT] helps me to remember those vocabulary actually. It helps me to make a deep impression [on the vocabulary] in my mind because I'm checking it all the time [Qing, interview].

When consulting this tool Qing evidently double-checks the translation provided by MT and evaluate its accuracy. The activity of MT evaluation helps the student strengthen word images and meaning input each time she checks the accuracy of translation from MT, through which she can learn more vocabulary. Qing's comments support Ying's response to the open-ended question, 'In what ways do you think MT/PEMT (MT+PE) is helpful in advancing your English reading and writing capabilities':

> I think it can help me a lot because I can get some more accurate words and sentence structures through translating [with MT] [Ying, questionnaire].

The two students' comments suggest that using MT, whether it is for reading or writing, appears to increase opportunities to learn vocabulary and grammar, especially when students evaluate MT output to determine whether it is accurate or requires PE. The multiple data sources indicate that MT and PE may provide students with more exposure to bilingual lexical and syntactic items and increase opportunities to learn the features of English vocabulary and grammar or lexico-syntactic patterns.

6.2.4 Increasing confidence in academic learning

Learning to use MT and PE helps the students increase efficiency in reading and improve accuracy in text comprehension and production, as discussed earlier. In turn, those advances seem to help increase their confidence in achieving academic learning and study through EMI. Ying claimed in the follow-up email correspondence that MT is especially beneficial for students:

> who just start to write [their] academic essays. That is a process from being lack of confidence of their own writing to be[ing] more independent [in their writing] [Ying].

In the opinion of Ying, novice L2 academic writers such as EMI students at the early stage of their study may need MT more or use MT more frequently owing to a lack of confidence in producing appropriate academic writing, given that academic writing in L2 requires practice, experience, and useful tools (Yoon, 2016). It can be assumed that such students may also lack familiarity with the study content, which means that MT to some extent may help EMI students not only build confidence in their academic writing but also familiarise themselves with learning content.

Learning to use MT and PE in the intervention seems to have helped students find solutions to linguistic difficulties in their postgraduate study, as indicated by Qing:

> I know I have a choice, if I need to get help while I get stuck into the ideas or the expressions. I know where I can find the assistance [Qing, interview].

Qing recognises that she is better able to solve language-related problems after the intervention. When struggling for language issues such as expressing herself in English, Qing will consult MT. Ability in using MT to overcome linguistic difficulties has also helped Yun build confidence, as she said in the questionnaire, '[MT] helps me to gain confidence'. The remarks by Ying, Qing and Yun reveal that understanding how to use MT and PE may reduce the feeling

of helplessness when language-related difficulties arise, and increase the confidence of these EMI postgraduate students in academic learning and study. It is possible, therefore, that MT and PE may increase EMI postgraduate students' confidence in academic learning, including academic reading and writing, which in turn may support students to learn both language and content knowledge.

6.2.5 Raising awareness of appropriate use of MT

Learning to use MT and PE may advance L2 English and content knowledge learning by helping raise students' awareness of appropriate use of MT. The students in this study have come to understand how to use MT appropriately during and after the intervention, as shown below:

> …through our exchanges and communication, we know how to utilise MT more effectively. And we got to know the different characteristics of different machines and that's good [Lian, interview].

> I learned more techniques about how to use different machine translation tools. That's very important to me. I can upgrade my MT abilities [Xiang, interview].

> Before I only used Youdao or Baidu, and now I start to use Google…I can see other people's ways of using the machine translation to do their own study [Ying, interview].

The quotations from the students show that the intervention through the collaborative tutoring process provided them with opportunities to exchange their experiences and strategies in using MT to progress their postgraduate study. Learning to use MT and PE allowed the students to find the distinctions between different MT tools, which seems to help them understand how best to choose and use MT resources in their fields of study. As Ying said above, 'Before I only used Youdao or Baidu, and now I start to use Google'. This again indicates that different MT tools may complement one another, thus making strategic use of various MT resources may best meet individuals' needs and encourage them to use MT critically and judiciously.

6.2.5.1 Using MT critically

Some students reported becoming more cautious when using MT since the start of the intervention, for example:

> I used [MT] a lot before, I was very bold in terms of using machine translation; now I have to be more cautious. Because sometimes when you [teacher researcher] show the translations, there are maybe a few mistakes [in the MT output]. I need to be very careful [Xiang, interview].

> I used MT before, and I will still use it. I will be cautious when using it [Lian, interview].

Following my demonstration during the intervention of how to use MT and PE, Xiang recognises that MT might produce incorrect translations that she might overlook, while Lian says that she will use MT with care. These comments indicate that the intervention with teaching practice helped students to understand that MT should be used cautiously, critically, and through evaluating MT output. This is evidenced by how Lian critically evaluated MT Chinese output prior to post-editing and paraphrasing it into Chinese (Figure 6.6, Steps 2 and 3) and how she evaluated MT English output before post-editing it into English (Steps 5 and 6).

The numerical data support this finding. When responding in the post-intervention questionnaires to the closed-ended item, 'I always do post-editing or proofreading when I use MT', all six students agreed (see Appendix 6.1). Three students (Yun, Lian, and Ying) changed their answers from disagree/somewhat agree in the pre-intervention questionnaire to agree in the post-intervention questionnaire. Qing agreed in the post-intervention questionnaire, having not had an opinion at the time of the pre-intervention questionnaire. Two students (Peng and Xiang) changed their responses from strongly agree to agree. Xiang clarified this in the email correspondence:

> I changed my answer because I found out that I don't do enough proofreading or post-editing compare[d] to other participants [Xiang].

This means that the collaborative tutoring pedagogy in the intervention led Xiang to a critical reflection of her MT use. Analyses of the multiple data sources reveal that before the intervention three of six students in this study might not always cross-check and evaluate MT output. However, they became aware of the importance of cautious use of MT during the intervention and reported that they would make more critical use of MT in future. Explicit teaching of MT and PE may therefore increase students' awareness of appropriate and critical use of MT by evaluating MT accuracy prior to accepting its translation.

6.2.5.2 Using MT judiciously

Due to the intervention some students recognised their excessive use of MT and now plan to reduce their dependence on the tool. In response to the open-ended question in the questionnaire, 'To what extent do you think this MT and PE tutoring group is helpful?' Xiang wrote:

> …it made me realize how to use MT correctly without relying too much on MT. So, MT can be beneficial to my English learning instead of hindering my English learning [Xiang].

Following the intervention Xiang considers that making use of MT is useful for English learning, but overly relying on MT might carry negative effects. Lian also indicated a similar opinion:

> I try to use it [MT] just as a tool and not rely on it…if you want to improve English reading and writing, you need to find the balance [Lian, interview].

The comments by Xiang and Lian indicate a decision to treat MT only as a resource to support their academic learning rather than relying too much on the tool in terms of English learning. They begin thinking about finding a 'balance' between using their own human translation (HT) and MT. From these data, the intervention appears to have helped the students understand the importance of using MT judiciously.

In contrast to the students who reduced their excessive use of MT, during and after the intervention some students turned a negative attitude towards MT into a positive:

> Before, I really disagreed with using translation machine in writing, but now I begin to use it in my writing. I think it's helpful [Qing, interview].

> I didn't expect it [MT] was so effective during the translation process so I think I will use it more regularly in the process of my academic writing [Peng, interview].

> I wouldn't know MT has progressed as a good tool for students if it wasn't this group [Yun, interview].

The above data reveal that before the intervention these three students did not believe MT to be helpful for academic writing or academic learning more broadly; however, during the intervention they discover it to be a beneficial resource. The three students begin to include MT as a tool in their postgraduate study because they find its usefulness.

On the one hand, the intervention reduces some students' over-dependence on MT; on the other hand, it increases other students' level of trust in MT as a useful tool. Taken together, learning and developing capabilities in MT and PE may increase students' awareness of using the tool critically and judiciously. Closer attention to the connection between content, meaning and language through the analysis of MT can help to advance students' language and content learning.

6.3 Chapter summary

This chapter has presented findings and preliminary analysis from Student Group 2, six Chinese-speaking postgraduate students studying in an EMI context. Regarding RQ1, the multiple data sources reveal students' five purposeful uses of MT and related strategies:

1) To look up words or phrases: The students use MT as a multilingual dictionary to translate words or phrases for reading and writing tasks and to understand word usage.

2) To support academic reading: The students adopt MT to check their comprehension of English texts, to translate large language units to help them understand difficult texts, and to speed up reading to search for materials for more in-depth reading.

3) To support academic writing: The students use MT followed by PE (MT+PE) to clarify thoughts and express their intended meaning in English, and to check their written English and assist with revision.

4) To help maintain academic integrity: The students use MT+PE to reduce similarity between the original and their paraphrased or summarised texts and improve accuracy in paraphrasing or summarising. They also adopt MT+PE to support comprehension and paraphrasing of more difficult academic texts.

5) To cross-check and evaluate MT output: The students adopt more than one MT tool together with additional online resources to cross-check MT output and evaluate MT accuracy. Independently of explicit intervention in this study, some students indicate that they pre-edit MT input to increase MT output accuracy.

Analysis of how students use MT suggests that the capabilities in MT and PE entail expertise in using MT as a tool (incorporating additional resources such as search engines) and MT+PE as a strategy combination. This combination embraces MT evaluation, MT modification, and skills of consulting tools, making decisions, and solving problems.

Regarding RQ2, the multiple data sources show that learning and developing MT and PE capabilities may not only advance L2 English learning but also facilitate access to content knowledge through five interrelated processes. These are:

1) Increasing efficiency in reading

2) Improving accuracy in L2 text comprehension and production

3) Increasing opportunities for learning vocabulary and grammar

4) Increasing confidence in academic learning

5) Raising awareness of appropriate use of MT.

Increased efficiency in reading is associated with improved accuracy in text comprehension and subsequent text production, which simultaneously increase opportunities for learning vocabulary and grammar. These in turn boost confidence in academic learning. Also, increased awareness of how to make appropriate use of MT (i.e., using MT critically and judiciously) helps students in learning both English and content knowledge.

7 Widening the lens: SLA, translation, translanguaging

The combined study, comprising Student Group 1 (SG1) and Student Group 2 (SG2), is driven by two research questions (RQs) to address the core aim of this research: the potential of machine translation (MT) and post-editing (PE) of machine translated texts to advance L2 learning in the contexts of language learning and teaching and EMI. The two student groups differ in some respects and share similarities in others. Students in SG1 are advanced learners of Chinese studying in a predominantly Chinese language context at National Taiwan University. Students in SG2 are Chinese-speaking learners studying postgraduate degrees through English medium instruction (EMI) in a predominantly English language context at the University of South Australia. A common purpose among these students is to advance their L2 expertise towards high-level multilingualism. In here discussing together the two groups of students and the findings, students in SG1 will be referred to as Chinese language students and students in SG2 will be referred to as EMI postgraduate students.

RQ1 (How do multilingual learners use MT to support their L2 learning?) and RQ2 (Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?) have both been addressed in terms of the research findings – for SG1 in Chapter 5 and SG2 in Chapter 6. Preliminary analysis of the findings was included in each of these chapters. The purpose of the present chapter is to offer a meta-analysis of the findings from SG1 (Chinese language students) and SG2 (EMI postgraduate students) together.

Despite the differences in student linguistic contexts, the research findings exhibit similarities. With respect to RQ1, the combined findings from both groups reveal multilingual learners' five purposeful uses of MT:

- To assist with words and phrases for reading and writing, including using MT to look for meanings and translations of words and phrases, and to understand their usage by looking at sample sentences.

- To support L2 input comprehension, including using MT to speed up reading to search for learning materials for more in-depth reading, and to check reading to confirm or improve comprehension.

- To support L2 output production, including using MT+PE to facilitate translation and/or to support conveying the intended meaning, and using MT to check the accuracy of L2 writing and to assist with revision.

- To help maintain academic integrity, including using MT+PE to reduce similarity between source text and paraphrase, to improve own paraphrased or summarised texts in L2, and to support comprehension and paraphrasing more difficult academic texts.

- To cross-check and evaluate MT output, including using more than one MT tool and additional online resources to cross-check MT output, and using pre-editing of MT input to increase MT output accuracy.

The findings demonstrate multilingual learners' practical and strategic use of MT and PE to support L2 input (reading) comprehension and output (writing) production. In short, they use MT as a multilingual dictionary for single words or phrases and as more than a dictionary to translate larger language units for assisting reading comprehension, writing production, evaluating MT output, and maintaining academic integrity. They adopt MT+PE as a strategy combination to support meaning making and meaning transfer from one language into another. Analyses of students' use of MT reveal the nature of MT and PE capabilities.

In relation to RQ2, the combined findings from both groups show that when learning to use MT and PE in the interventions, five interrelated processes occur, through which students may not only advance L2 learning for either Chinese or English but also gain access to knowledge of learning content. The five interrelated processes are as follows:

- Increasing efficiency in reading

- Improving accuracy in text comprehension and production

- Increasing opportunities for learning and understanding vocabulary and grammar

- Increasing confidence in learning

- Raising awareness of appropriate use of MT.

In this chapter, I discuss the above findings in more depth as they suggest that a deeper analysis and discussion from different theoretical lenses is warranted. This meta-analysis focuses on an examination of the interaction between human and machine translation (hereafter, human-

machine interaction) in relation to both groups of students and considers how this contributes to prior literature and research in SLA, translation and translanguaging.

In Section 7.1, I discuss students' purposeful use of MT and the process of PE in relation to language learning as understood through interactionist SLA theory. Although this theory is primarily used to understand how languages are learned in human-human interaction, a small body of work has connected interactionist SLA theory to computer-assisted language learning (CALL). I draw on this work to discuss how human-machine interaction can advance language learning. In Section 7.2, I use Nida's (1969) three-phase translation model from translation studies to examine students' purposeful use of MT and their translation processes within the broader process of PE. This is to further understand how MT and PE can advance language learning through human-machine interaction. In Section 7.3, I consider MT and PE through the lens of translanguaging to understand implications for multilingual learning and pedagogy for learning language and content knowledge. This includes implications of MT and PE for achieving multilingualism and addressing concerns of academic integrity.

7.1 Implications of MT and PE: Human-machine interaction in SLA

Interactionist SLA theory (Chapelle, 2003, 2009) encompasses the components of input, interaction and feedback, output, and attention. When discussing this theory, one often includes the discussion of meaning-focused and form-focused learning together. I draw on these to examine students' purposeful use of MT and the process of PE to support their L2 input comprehension and output production. Specifically, based on findings, I examine how students use MT and PE to make input and output comprehensible and how this human-machine interaction on a multilingual platform can help language learning and acquisition.

7.1.1 MT making 'comprehensible input' possible: Reading and comprehension

The findings from both SG1 and SG2 in this research show that one purposeful use of MT is to support L2 input comprehension. Students' strategies include using MT to check their reading to confirm or improve comprehension, and to speed up reading to search for materials for more in-depth reading (see Sections 5.1.2.2 & 6.1.2). Rory, for example, used translation provided by Google Translate to check his understanding of the challenging reading text in L2 Chinese and found he had misinterpreted the Chinese text '*將人視作陶土, treat people as clay'* as 'rely on human sight as clay' (see Table 5.11). Likewise, Lian and Ying stated in interview that when they are not sure whether their interpretation of reading texts in L2 English is

accurate, they compare their own understanding with MT produced Chinese translation. In addition, some students (Rory, Lisa and Qing) adopt MT to speed up reading in L2 and gain a broad meaning of a text in order to decide what to read more carefully. Qing, for instance, used MT to accelerate reading in L2 English to locate reading materials for in-depth reading, and then used it again to increase understanding of the selected materials (see Figure 6.2).

Reading L2 texts, especially relatively difficult texts for students, side by side with L1 MT-produced translation allows students to speed up skim reading and also to engage in more intensive reading. This latter involves analysing and comparing the L2 source text and the L1 MT text, and appears to help students develop and expand bilingual vocabulary and knowledge of grammatical features while increasing understanding of the L2 text. As Qing said in her demonstration of MT use, 'I found it's [MT] helping my reading and grammar…I can learn the vocabulary quickly and then improve my grammar'. Qing's experience is supported by Ying's account of her process, 'I would read the [MT translated] sentence in Chinese carefully and break down the English sentence…so I would get the meaning' (interview). The comments reveal that the use of MT to increase reading efficiency and comprehension accuracy seems simultaneously to enhance opportunities for learning and understanding vocabulary and grammar, as indicated in Sections 5.2.3 and 6.2.3.

These findings suggest that L2 reading with L1 MT text to increase comprehension aligns with Krashen's (1985, p. 2) discussion of 'comprehensible input' because 'if input is understood…the necessary grammar is automatically provided'. When L2 learners cannot understand input, the reading material does not promote improvement of their grammatical knowledge of the language (Gass & Mackey, 2014). Qing and Ying's remarks above indicate that reading difficult L2 texts alongside L1 MT texts to make L2 input comprehensible seems to benefit learning of language features and knowledge.

In addition, the findings indicate that when reading challenging texts with MT, students can compare two parallel texts and languages (i.e., the source text in L2 and the MT text in L1). This suggests that students are more likely to progress their comprehension from understanding the meaning of the input at the semantic level to being able to analyse sentence structures (of input) at the syntactic level (Gass, 2017). Gass suggests that semantic comprehension precedes syntactic comprehension, and syntactic comprehension precedes acquisition. In the process described above students seem to move more easily from an implicit understanding of text to a more explicit awareness or analysis of the linguistic form of the text.

I therefore argue that reading challenging texts in L2 with L1 MT-produced translation may increase comprehensibility of input and extend semantic understanding to a higher cognitive level of syntactic analysis. At the same time, using L1 MT text as an additional source of meaningful input may fill linguistic gaps in L2 (e.g., vocabulary and grammar) and thereby facilitate acquisition of additional vocabulary and grammar in L2. As shown in Rory's example (Table 5.11), when he noticed the parallel vocabulary and grammatical structure in L2 (*將人視作...*) and MT produced text in L1 (treat people as…), he could then make inferences about the vocabulary and grammar. This lexico-grammatical point was missing in his Chinese language system until he read the text with MT. Hence, reading L2 texts, especially more difficult ones, with L1 translation provided by MT appears not only to make L2 input comprehensible but also to trigger noticing two parallel texts in L1 and L2 and promote learning of vocabulary and grammar.

7.1.2 MT output as 'feedback' to check meaning and form

This study reveals that another purposeful use of MT for students is to support L2 output production. In this study, students' strategies primarily involve using MT as a resource to check the accuracy of meaning and/or form (word forms and syntactic structure) in their L2 written assignments and to assist revision. For example, some students such as Qing and Lian used MT to translate their L2 English writing into L1 Chinese to evaluate whether what they had written was equivalent to their intended meaning (see Section 6.1.3.2). This strategy allows students to determine whether modifications are needed in their L2 writing.

In addition to checking meaning, some students (Rory, Amanda, Yun and Xiang) used MT to check the accuracy of form in their L2 output, after which they undertook revisions. As shown in Table 5.13, after Rory completed his human translation (HT) from L1 English to L2 Chinese (Step 1), he used MT to translate the L1 source text to obtain L2 MT text (Step 2). Rory placed the L2 MT output under his L2 HT output in order to compare the two texts. He then used MT and additional human language technology (HLT[25]) tools such as Google Search to look up the meaning of the Chinese words/terms provided by MT and to double-check MT accuracy (Step 3). Rory revised his HT output and replaced his translation with the translation from MT if he

[25] One application of HLT includes web-based resources such as online machine translation (MT), online dictionaries, search engines, and corpora (Bodomo & Lam, 2006).

considered it more appropriate than his own translation (Step 4). Figure 7.1 shows Rory's four-step process of using MT to check and revise HT.

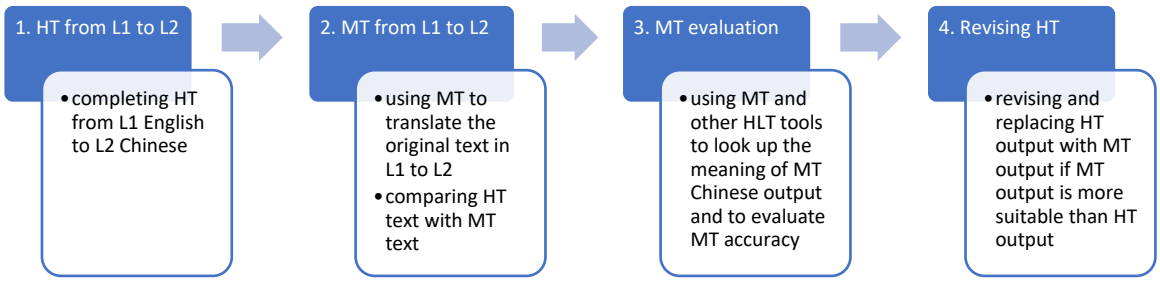


Figure 7.1 Rory's four-step process of using MT to check and revise HT

Rory employed L2 translation produced by MT to compare and check the accuracy of vocabulary and grammar (lexico-grammatical patterns) in his L2 written output and to make revisions when needed. In so doing, Rory's revision shows improvement in Chinese word choice, word usage, word order, and sentence structure (see Table 5.13). This example shows that the L2 MT output functions as written feedback, which serves a similar function to that of an L2 teacher's recasting in an L2 learning-teaching setting.

The findings support previous research that students benefit from using MT to help revise their L2 writing or translation (Chen et al., 2019; Chen & Tsou, 2023; Clifford et al., 2013; Jolley & Maimone, 2022; Lee, 2020; Lee & Briggs, 2021; Tsai, 2020). The findings also detail students' processes, strategies, and purposes for using MT to assist with L2 writing revision as follows. First, students checked the accuracy of meaning, i.e., whether their L2 writing output expressed their intended meaning. Second, they checked the accuracy of form, i.e., whether their L2 writing was appropriate in terms of lexical-grammatical features. The two strategies helped students to decide whether, and if so, how to make revisions.

Scholars of interactionist SLA theory (e.g., Ellis, 2015; Long, 1996) argue that language learners can receive feedback from target language speakers or interlocutors on both correctness and incorrectness of their utterances through real-time spoken interaction. In other words, in *human-human interaction* as suggested by Gass and Mackey (2014), feedback is given to confirm the accuracy of an utterance, to clarify the meaning of an utterance, to check comprehension for an utterance, and to recast a non-target-language-like utterance to a more target-language-like sentence while retaining the original meaning. In addition to interpersonal interaction, Ellis (1999) points out that interaction 'can also refer to the intrapersonal activity involved in mental processing' (p. 3). Furthermore, scholars such as Chapelle (2003, 2009)

have connected interactionist SLA theory to CALL to explore language learning with technology, focusing on learner-computer interaction while including spoken and written communication modes. Chapelle (2003) has argued:

> …interaction takes place not only in face-to-face conversation but also electronically over a computer network…interaction needs to include what takes place between a person and the computer (p. 55).

I view interactions between learners and computers as *human-machine interaction*. In human-machine interaction, as shown in the findings of this study, the students interact with MT and use MT output as feedback to evaluate the accuracy of their written text (HT text), in terms of both meaning and form, to increase the appropriateness of their written output (HT output) through revision. In Rory's Figure 7.1 process (detailed in Table 5.13), the MT feedback seems to help him recognise his areas of frailty with Chinese grammar (e.g., passive voice) and Chinese word choice (e.g., *取消, cancel vs 剝奪, strip off*). In other words, his use of MT output to check against his own HT output enables him to pay attention to (or notice) his linguistic gaps in Chinese. This supports Lee's (2020) view of MT as a tool to provide feedback for students' L2 writing:

> MT functioned as an individualized feedback system for each student…it was sufficient to show alternatives, which required them to give their word choice more thought and double-check their grammar and expression (p. 169).

The findings of the present study show that using MT output as feedback or employing MT as a *checking tool* can draw students' attention to the appropriate use of language and raise awareness of linguistic gaps in their internal linguistic system. This not only gives students additional opportunities for 'noticing the gap' (Schmidt, 2001, 2012), but also raises an awareness of a need to learn, which is the first step towards effective L2 learning (Gass, 2017). As shown in Table 5.13, MT feedback serves a similar function to human recasting in spoken interaction, and allows Rory to notice and compare his incorrect use of the passive voice with the MT version and then correct it.

The findings, however, also unveil an important step: evaluating MT accuracy prior to accepting translations generated by MT, a matter not fully identified in previous CALL research, particularly in the area of MT. Scholars in MT research such as Lee (2020) and Tsai (2020, 2022) proposed that MT can be used as a CALL tool to assist students' L2 writing and revision. They taught students to make use of MT to compare MT output against their own HT output and make revisions as appropriate; however, unlike the present research, their studies

do not draw attention to the potential of MT for purposes of evaluation or making judgements of MT accuracy.

As shown in Figure 7.1, the MT evaluation step requires the student to employ additional HLT tools to check the suitability of terms and word collocations produced by MT (see also Table 5.13). This seems to be an important step in helping the student make informed decisions on word choice and word usage, and the extent to which MT output needs to be accepted or modified. The implication for language teaching/teachers is that students may need to be reminded to evaluate the accuracy of MT, potentially through consultation with additional HLT tools, before accepting translations from MT. Capability in MT evaluation can be developed and strengthened through the practice of MT+PE (Chang, 2022; Niño, 2008, 2020; Zhang & Torres-Hostench, 2022). This means that when introducing MT to students, it is beneficial to include both MT and PE as related and interdependent activities to guide students in making appropriate and critical use of MT.

7.1.3 MT+PE entailing both meaning-focused and form-focused learning

The findings also show how students use MT to support L2 output production through MT+PE to help with transfer of meaning from one language (e.g., L1) to another (e.g., L2). Students use MT+PE to facilitate translation when attempting to increase the accuracy of written production (see Sections 5.1.2.3 & 6.1.3.1). For example, from the screenshots in Table 5.6, it can be seen that Maggie employed MT+PE with Google Translate to complete translations from L1 English to L2 Chinese. She moved back and forth between the English source text and the MT Chinese text followed by PE. Specifically, Maggie used HLT tools including the pop-up dictionary and the Pleco dictionary to look up the meaning of Chinese words produced by MT, allowing her to evaluate MT accuracy, and then to edit and modify unsuitable MT output. If one were to adapt or extend the arguments in interactionist SLA theory, Maggie's process of MT+PE from L1 to L2 could be summarised as input, negotiation for meaning and negotiation of form, and output (see Figure 7.2).

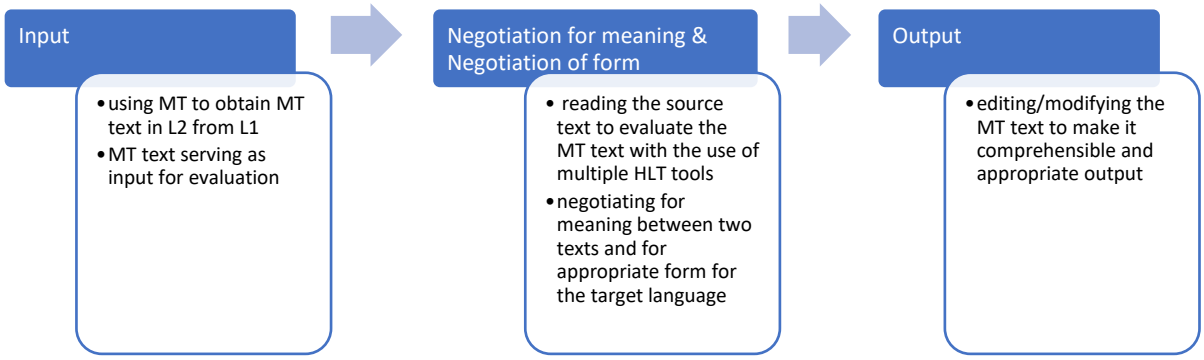


Figure 7.2 Relating Maggie's process of MT+PE to interactionist SLA theory

As discussed in Chapter 5 (see Table 5.6), Maggie first used MT to translate the source text in L1 English to obtain MT text in L2 Chinese. The MT text in Chinese serves as input for Maggie to assess accuracy. Maggie then read the source text to evaluate the MT text with the use of HLT tools. For instance, she read this source sentence, 'she gazed into my eyes as if searching any sediment of courage at the depths of them', and then read the sentence translation made by MT, '*她凝視著我的眼睛，彷彿在他們的深處尋找任何勇氣的沉積物*'. The second half of this MT text sounded very unnatural because of the problematic use of the pronoun and word choice. Maggie read this Chinese translation with the pop-up dictionary to look up the meaning of the words '*深處,* depth' and '*沉積物 sediment*' and then she consulted the Pleco dictionary app. Following the evaluation of this MT sentence, Maggie subsequently edited the awkward translation to a comprehensible and appropriate sentence, '*彷彿在眼裡的深處尋找任何一絲一毫的勇氣， as if searching any tiny bit of courage at the depth of eyes*'. This shows that Maggie translated the main meaning of the source text rather than sticking to the equivalence of form, and that she negotiated for meaning between texts and negotiated for appropriate form for the target language with the use of dictionaries. I therefore suggest that this MT+PE process illustrates the interaction between humans (the student) and machines (MT and dictionaries) and intrapersonal activities (cognitive processing), and thus could be regarded as an extension of interactionist SLA theory and CALL research in a writing context.

In this study, the other students' processes in using MT+PE were similar to Maggie's sequence of steps described above, although they each used their preferred HLT tools when looking for meaning and form. In brief, the students obtained MT text as input, followed by a process of negotiating for meaning and negotiation of form to edit/modify MT output. This was for the purpose of producing appropriate output production that would be close to the meaning of the source text, and linguistically and culturally appropriate in form. This finding suggests that

MT+PE entails meaning-focused and form-focused learning (Ellis, 2015; Long, 2014) and a great deal of 'noticing' (Schmidt, 2001). The students initially processed the source text and MT text for meaning while intentionally being attentive to form. As Niño (2008) suggests, post-editing 'provides opportunities for error correction through focus on form and negotiation of meaning' (p. 44). The students in this study engaged in negotiation of form while negotiating for meaning between the source text and language and the MT text and language.

During negotiation for meaning and of form, the students consulted additional tools to find answers to linguistic queries so as to make decisions on how to edit the MT text to make it appropriate and comprehensible. This activity resembles editing HT output to achieve enhanced translation quality (Carmo, 2017; Niño, 2008). In this sense, MT+PE may align with Swain's (1995, 2005) view of producing 'comprehensible output' or making modifications to the output. Although Swain's (1985) initial output hypothesis focuses on spoken modalities, she later argues that 'the act of producing language (speaking or writing) constitutes…part of the process of second language learning' (Swain, 2005, p. 471). Thus, producing written output or making output comprehensible plays an important role in strengthening syntactic knowledge and promoting L2 learning. In extending this argument here, I suggest that MT+PE can advance L2 learning by improving accuracy in L2 output production (see Sections 5.2.2.2 & 6.2.2).

In MT+PE, students in this study do not focus on producing their own output from scratch; however, they pay attention to edit and/or modify MT output through analysing the meaning and form of the source and MT texts and languages. The students reflect on how language is used in the source and MT texts and whether the sentences produced by MT are grammatical. Thus, the process of MT+PE may help students develop metalinguistic capability. This finding draws close to Swain's (1995, 2005) recognition of the metalinguistic (reflective) function of language use, and also to the work of Gass (2017) who regards language not only as a tool for making meaning, but also as an object of inquiry.

As discussed thus far, students in this study use their linguistic resources and collaborate with machines to maximise their learning in relation to comprehension and production in the target language. They draw on their linguistic capabilities in at least two languages (English and Chinese) and on both their own human intelligence and machine intelligence in an effort to increase their L2 input comprehension and the appropriateness of their L2 output production. The findings indicate that students strategically use their multilingual capability and MT to make L2 reading and writing more efficient and effective. Some previous literature has

explicitly connected CALL research to SLA theory, observing L2 acquisition in human-human spoken and/or written interactions through computer-mediated platforms (Chun, 2016; Ortega, 1997; Salaberry, 1996; Tudini, 2007). Chapelle (2009) has particularly applied interactionist SLA theory to examine L2 acquisition in CALL contexts and has proposed the effectiveness of CALL strategies involving the internet, multimedia, software, and digital resources in facilitating language learning. However, few CALL studies that focus on MT in language learning and teaching have established clear connections with SLA theory. Jolley and Maimone (2022) argue that 'connections between language acquisition theory, learning outcomes, and MT use are rarely found in the MT literature' (p. 34).

This current study contributes to the absence identified by Jolley and Maimone (2022) and considers students' MT use and language learning in terms of interactionist SLA theory. In addition to assisting with self-revision of L2 writing (Chen et al., 2019; Lee, 2020; Lee & Briggs, 2021; Tsai, 2020, 2022), this study indicates that MT can facilitate both reading comprehension and writing production while advancing learning of language and content knowledge. As prior literature suggests, advances in digital technology may shift the way in which learners understand and make meaning and access information and knowledge (Chapelle, 2003; Dingli & Seychell, 2015; Douglas Fir Group, 2016). This points to a necessity for teachers to draw on technology to create new approaches to language teaching (Chun, 2016; Gao & Yang, 2023). Ortega (2017) argues that digital communication motivates multilingual practices, and multilingualism develops through digital communication. In the same vein, I suggest that MT and PE as CALL strategies and resources can encourage multilingual practices and multilingualism through human-machine interaction, and that this is an 'intellectual partnership' between learners and technology (see Salomon al., 1991, p. 3). This broadens conventional language learning modes confined to human-human interaction and native speaker bias in monolingual pedagogy. As Palfreyman and Benson (2019) argue, the development of technology offers language learners 'new interlocutors and ways of interacting, new spaces, new roles, new possibilities' (p. 671).

Furthermore, the findings and discussion in this study indicate the potential value of expanding dimensions of language teaching to include translation, especially MT and PE, to leverage learners' access to and use of a wider range of linguistic resources than those used in conventional SLA or language pedagogy. Ortega (2013, 2017, 2019) has argued that the focus of SLA needs to broaden to encompass multilingual perspectives that include students' whole linguistic repertoire. This has significant implications for language learning and teaching,

particularly in regard to understanding how to use students' multilingual resources in language education. I suggest that our understanding of linguistic repertoire might well need to be expanded to embrace learners' full range of linguistic skills, including not only knowledge of languages and cultures but also capabilities in translation and technology (MT and additional HLT tools). I further suggest that such an expanded view of repertoire has implications for language pedagogy. Increased opportunities to enhance multilingual learning through human-machine interaction may contribute towards the development of high-level achievement of multilingualism. Multilingual learning and pedagogy are further discussed below through a translation lens.

7.2 Implications of MT and PE: Human-machine interaction in translation

Pedagogical translation (Leonardi, 2010) or translation in language teaching (Cook, 2010) incorporates the perspectives of both language teaching and translation studies. The aim is to use translation as a pedagogical approach to develop and enhance language capabilities through translation tasks or activities (Pintado Gutiérrez, 2021). As explained in Chapter 4, I draw on Nida's (1969) three-phase translation model in translation studies to analyse and discuss the function and role of MT and PE in the translation processes of students in this study.

Nida's three-phase model comprises an analysis of the source text, a transfer of meaning corresponding to the expectations of the target language, culture and conventions, and a restructuring of the target/translated text. In the first phase, the semantic and grammatical elements of the source text are analysed to facilitate understanding of text information. Nord (2005) views this phase as a source text comprehension stage. In the second phase, the focus is on interlingual and intercultural text transfer to achieve equivalence in meaning between the source and target texts. The target/translated text needs to conform to the target language conventions and norms. In the third phase, translation and restructuring of the transferred items are intended to produce a linguistically and culturally appropriate target text. I illustrate Nida's three-phase model of the translation process in Figure 7.3.

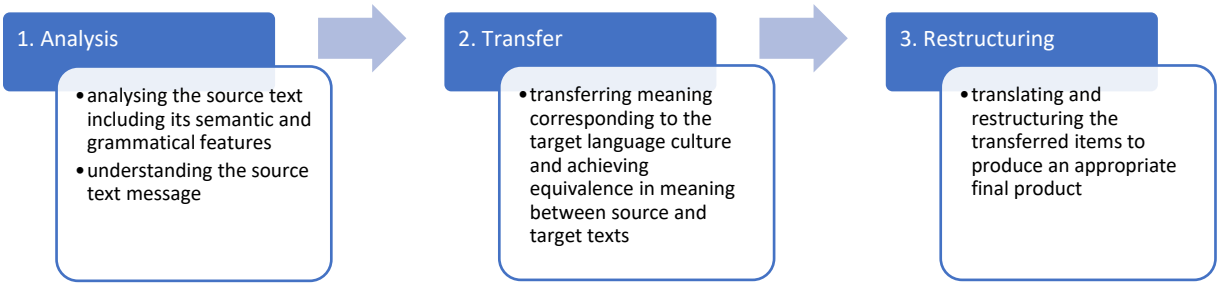


Figure 7.3 Nida's three-phase model of the translation process (adapted for illustrative purposes here)

As discussed in the previous section, students from SG1 and SG2 make use of MT as a resource to assist L2 reading comprehension and writing production (similar to Nida's Phase 1 and Phase 3), and they use MT+PE to assist with the process of making a transfer of meaning from L1 to L2 and vice versa. In this section, using Nida's model, I analyse the students' translation processes to understand more about the functions and roles of MT and PE.

7.2.1 MT as a resource in HT processes

From the screenshots in Section 5.1.1 (see Table 5.1, Table 5.3, and Table 5.7), it is evident that the HT processes of Rory, Lisa and Amanda in the pre-intervention tasks all involved the use of MT (Google Translate) as a tool to translate various language units – words, phrases and sentences. Rory and Amanda also used translation provided by MT to check against their HT output for revisions to their HT text. When they were unsure about MT output accuracy, they employed dictionaries and/or Google Search to double-check the translations from MT. In Figure 7.4, the three students' HT processes are mapped to Nida's three-phrase model. In the analysis phase, the students analysed the semantic and grammatical components of the source text and grasped the source text meaning in consultation with MT and additional HLT tools. In other words, they employed a variety of tools to solve linguistic problems when analysing the source text. For example, Lisa used MT and the Line dictionary to look up the meaning of the Chinese idiomatic expression *'同舟共濟, all in the same boat'*. Amanda adopted MT and the Firefox browser pop-up dictionary to figure out the meaning of the difficult sentence *'目前的教育太過將人視作陶土, current education overly treats humans as clay'*. As indicated by Nord (2005), the analysis phase assists in an increased understanding of the source text.

The students then worked on how to transfer the meaning from the source language to the target language in ways corresponding to the target language and culture. At this transfer stage, they also used MT and other HLT tools to solve translation problems and to make decisions on how best to convert meaning into the target language and to achieve equivalence. For example,

Amanda adopted MT and dictionaries to assist with translating the above difficult sentence from Chinese to English. Her strategy to solve the translation problem was to obtain a translation from MT and follow that by PE (MT+PE) to make the MT output more appropriate, as shown in Table 5.7.

In the restructuring phase, the students not only translated and restructured but also edited and revised their translations with the aid of MT. For instance, Rory checked and compared his HT output with MT output, which enabled him to find his misinterpretation of the source text meaning. He subsequently edited and revised his HT text to generate his perception of a more suitable translation. Figure 7.4 illustrates the three students' HT process following Nida's (1969) model.

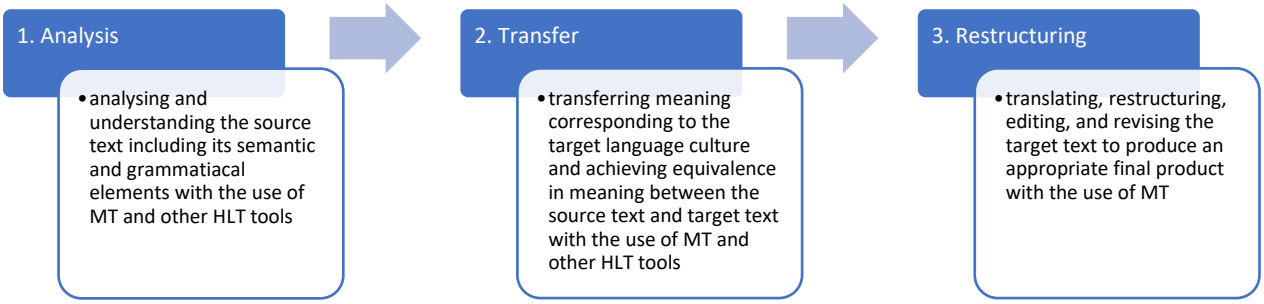


Figure 7.4 Relating the HT process of Rory, Lisa and Amanda to Nida's three-phase model

According to the screenshots of the students' translation processes in Section 5.1.1, the students' three-phase process is a repeated cycle for each sentence (see Figure 7.5). That is, the students usually went through the three phases at the sentence level, although the editing and revising activities occurred after the completion of the translation. Also, the whole translation process from analysis, transfer, to restructuring involved consulting a variety of tools, making decisions, and solving problems, as shown in Figure 7.5.

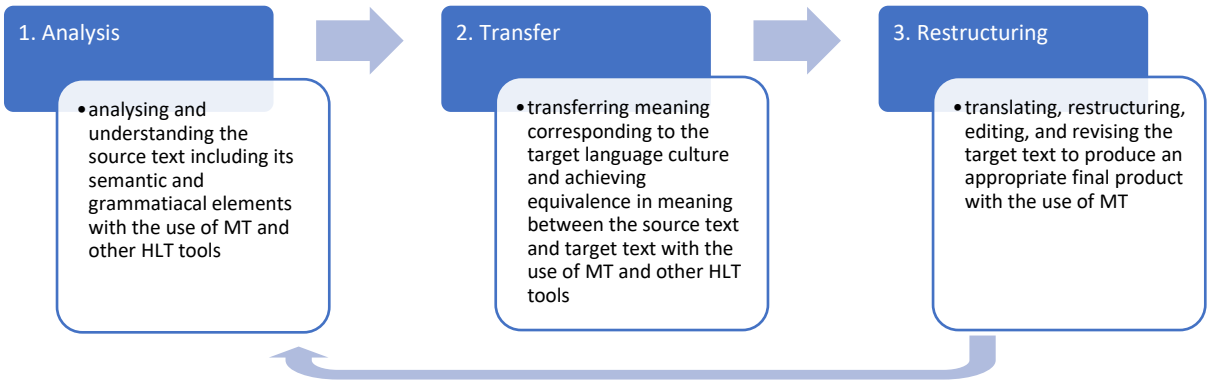


Figure 7.5 HT process of Rory, Lisa and Amanda

Analysis of the findings in Figure 7.5 suggests that MT is used from the text analysis phase through to the restructuring phase, and thus from reading to writing activities in the translation process. More specifically, MT is not only used to assist translation of different language units for analysing and understanding the source text and transferring the meaning between languages, but it is also used to check and compare with HT output for making revisions. The findings of this study corroborate previous research, indicating that students use MT for reading comprehension (e.g., Bahri & Mahadi, 2016; Heugh et al., 2022; Niño, 2020) and for checking their writing or translation and making revisions (e.g., Clifford et al., 2013; Lee, 2023). This current research, however, further details that both Chinese language students and EMI postgraduate students employed MT not only as a multilingual dictionary to look up words and phrases in the translation process but also as more than a dictionary. That is, they used MT to translate larger language units to understand source texts in L2 more fully, to check the accuracy of their L2 comprehension and production, and to produce more appropriate output in L2, as discussed in Section 7.1.

In addition, the findings related to the students' translation processes seem to reflect and expand Nida's model and indicate that translation is not a linear process but recursively repeated or cyclical. They also show the complexity of translation processes, which entails cognitive skills, capabilities in at least two languages, and the skills of consulting a range of tools, solving problems, and making decisions (Alves & Hurtado Albir, 2010; Tasker, 2016). Cognitive skills such as 'predicting, observing, noticing, thinking, reasoning, analysing, interpreting…focusing, guessing, comparing, differentiating' (O'Sullivan, 2007, p. 277) have been seen as essential for language learning and problem solving (Thomas et al., 2022). The findings related to students' HT processes in this study importantly also reveal areas of

collaboration between humans and machines to accomplish complex metacognitive and metalinguistic activities. The findings in relation to how students work with machines and how they expand their language capabilities are further discussed through students' MT+PE processes below.

7.2.2 MT+PE as a strategy combination to facilitate translation

The screenshots in Table 5.3 and Table 5.7 show that Lisa and Amanda adopted MT+PE as a strategy combination to solve translation problems when undertaking HT. The screenshots (Table 5.2, Table 5.4, Table 5.6, and Table 5.8) also reveal that all four Chinese language students used MT+PE to complete their translations in the post-intervention tasks, although Maggie used MT+PE only for translating from L1 English to L2 Chinese. While each of the four students had their own ways of using MT+PE, they all followed three steps:

1) use of MT to translate a source text to obtain MT output

2) evaluation of MT output accuracy

3) editing and/or modification of MT output.

Three students (Rory, Lisa and Amanda) used more than one MT tool while one student (Maggie) adopted only one MT tool to obtain MT output in Step 1. Whether they used MT output as a draft or as points of reference, the four students read and compared the source text and MT text in Step 2. They also adopted MT and additional HLT tools to evaluate MT output. In Step 3, they edited and/or modified MT output to make it an appropriate translation. The screen recording data show that Steps 2 and 3 are a repeated cycle for each language unit being translated, whether this is at the word, phrase, or sentence level. The data also reveal that Steps 2 and 3 involved consulting various HLT tools, solving problems in relation to the appropriate use of language, and making decisions on how to edit or modify MT output (see Figure 7.6).

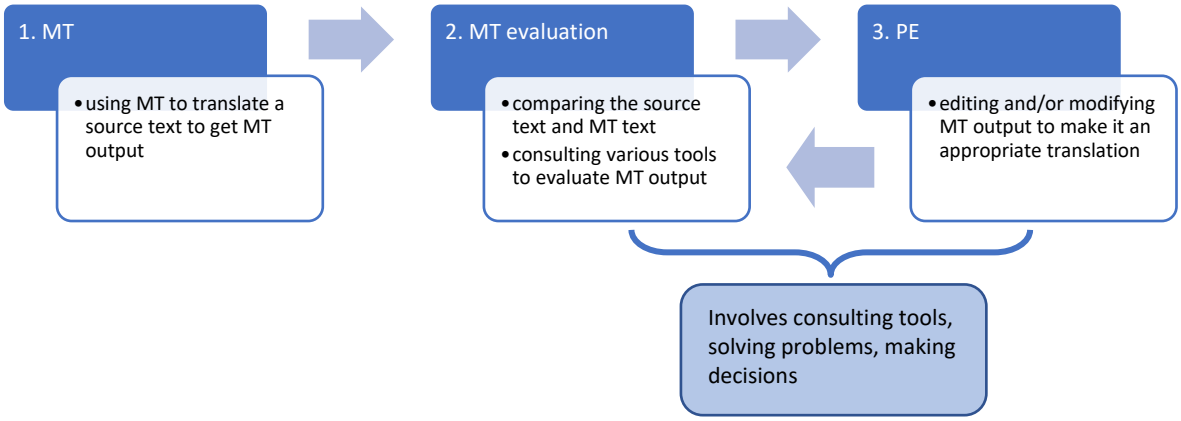


Figure 7.6 MT+PE processes used by the four students in SG1

As shown in Figure 7.6, the findings related to the students' MT+PE processes in this study are in line with previous research, indicating that PE involves a process of editing, modifying and/or revising the machine translated text to achieve an acceptable translation (Allen, 2003; García, 2012). However, the findings also unveil MT evaluation as a distinct step, which comprises several sub-steps and plays an essential role prior to PE. The findings support earlier research, indicating that MT+PE activities lead to MT evaluation and modification (Chang, 2022; Niño, 2020; Zhang & Torres-Hostench, 2022). The flowchart below extends Nida's model, showing the importance of MT evaluation through MT+PE in the translation process (see Figure 7.7).

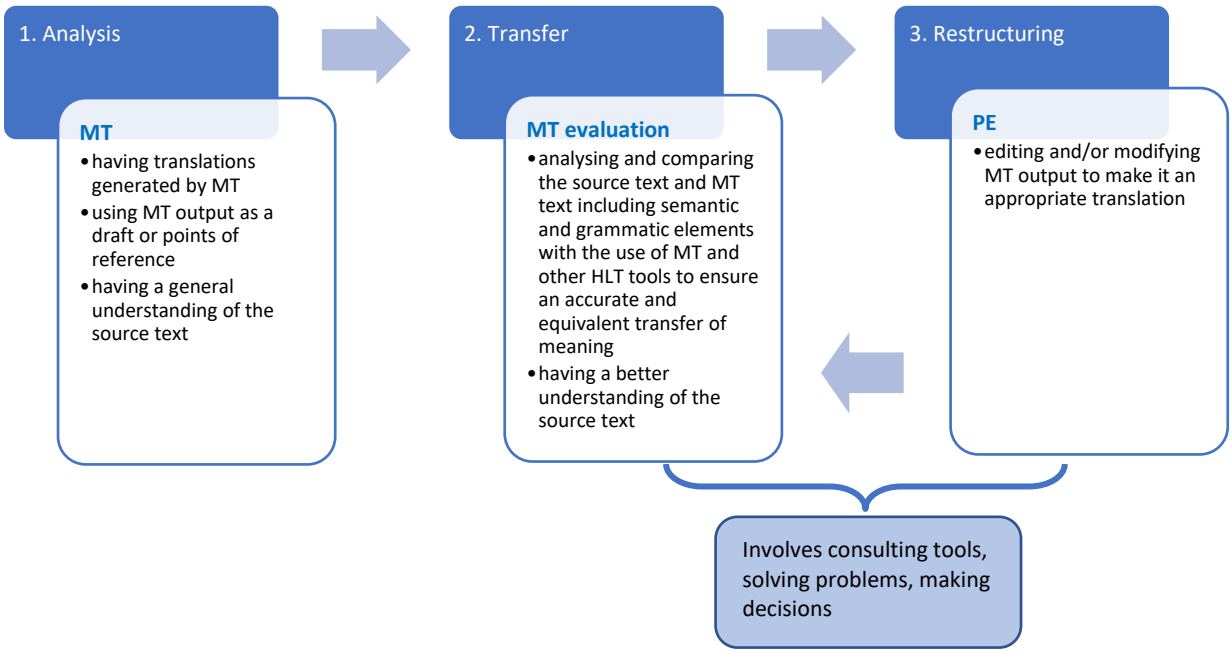


Figure 7.7 Relating Nida's three-phase model to MT+PE processes of students in SG1

In the following analysis, to clearly distinguish between the student processes identified previously in students' use of MT (Chapters 5 and 6) I use the word 'step' to refer to findings in relation to the sequence of students' translation processes and use the word 'phase' when relating findings to Nida's three-phase model.

In the analysis phase (student Step 1), the L2 Chinese students used MT to translate the source text (in Chinese or English) to obtain MT output (in English or Chinese). They used the MT output as a draft and/or points of reference for PE. In this phase, they have only a general understanding of the source text and the text analysis of semantic and grammatical elements takes place in the next phase (the transfer phase). The following are examples from screen recording data (Table 5.14 & Table 5.8).

> *Example 1:*
>
> *Rory obtained paragraph translations in **English** from four MT tools: Google, Baidu, Youdao, and Microsoft. He skim-read the English translations and then chose the Youdao text (the best MT version in his view among the four) as a draft on which to perform PE. The other three MT outputs were used as points of reference to cross-check the Youdao output. In this phase he hopes to gain a general understanding of the source text in Chinese by reading the MT English output.*
>
> *Example 2:*
>
> *Amanda obtained paragraph translations in **Chinese** from Google Translate and the Baidu translator tool. She used Google output as a draft for PE and Baidu output as a point of reference to cross-check Google output. She might have a general understanding of the source text in English in this phase.*

In the transfer phase (Step 2), the students evaluated the MT text through comparing and analysing the source text and the MT text, including semantic and grammatical components, with the use of MT and other HLT tools. They tried to ensure or to seek as close as possible an accurate and equivalent transfer of meaning from the source language to the target/translated language. In so doing, they gained a better understanding of the source text. In the restructuring phase (Step 3), they then edited and/or modified unsuitable MT text to make it an appropriate translation. As indicated earlier, Steps 2 and 3 are repeated recursively and involve consulting tools, solving problems, and making decisions.

Example 1 continued:

Rory evaluated Youdao output in English through reading and comparing back and forth between the Chinese source text and the Youdao text in English. He also cross-checked the Youdao output with the other three MT outputs in combination with the use of Google search to further understand the meaning of the Chinese words/terms. Through analysing the semantic and grammatical components in both source and MT texts, Rory gained a better understanding of the Chinese source text. This helped him to edit and modify Youdao output to make it an equivalent translation in ***English****.*

Example 2 continued:

Amanda evaluated Google output in Chinese through reading and comparing back and forth between the English source text, the Google Chinese output, and the Baidu Chinese output. She also adopted the pop-up dictionary to assist in understanding word meanings when reading the MT texts in Chinese. Through analysing the semantic and grammatical elements in both source and MT texts, Amanda identified the semantic inaccuracy in the Google output and then revised it to an equivalent translation in ***Chinese****.*

Analyses of the above translation processes suggest that MT evaluation in the transfer phase is essential to achieve the objective of an appropriate transfer of meaning from Chinese to English and English to Chinese. This phase requires students to judge MT accuracy through carefully analysing, comparing, and interpreting the source text and the MT generated texts. Additional HLT tools are used to help understand and ensure the correct use of vocabulary and grammar so that students can further judge MT accuracy and edit unsuitable MT output. MT evaluation, hence, pushes students to pay attention to semantic, syntactic, and pragmatic features in the source and MT texts. On the one hand, this helps students gain a better understanding of the source text, which may subsequently enable them to produce a more appropriate translation from L2 Chinese to English, as shown by Rory's example above. On the other hand, students may be better able to generate a culturally and linguistically appropriate translation from English to L2 Chinese, as shown by Amanda's example above. This analysis is supported by translation scoring data in Table 5.16 and Table 5.17.

Among the five assessment categories[26] used to score students' pre- and post-intervention tasks scores for Chinese to English translation, the highest increase occurred in relation to source text meaning (source text comprehension). The top three categories with the largest increase in students' scores for English to Chinese translation were grammar and mechanics (linguistic competence), situational appropriateness (pragmatic competence), and style and cohesion (textual competence), respectively. These findings indicate that the processes of MT evaluation with MT+PE involve analysing both the source and MT texts, enhancing student understanding of the source text and production of more appropriate translation, which together contribute towards effective transfer of meaning. Learning how to use MT and PE may therefore advance both language learning and content knowledge learning by improving accuracy of input comprehension and output production (see Sections 5.2.2 & 6.2.2). The improved accuracy of text comprehension and production may concurrently increase opportunities for students to learn and understand vocabulary and grammar (see Sections 5.2.3 & 6.2.3). In other words, the findings indicate that the learning of both language and knowledge is driven by interrelated processes between improved text comprehension and production and increased opportunities to learn lexical items and syntax. The students increase understanding of learning content by means of working on vocabulary and grammar in context:

> …since I have to consider different possible translations and choose the most accurate one, thus it gives me a deeper understanding of the original text [Lisa, questionnaire].

> I would read the [MT translated] sentence in Chinese carefully and break down the English sentence. I break the structure of the English sentence, so I would get the meaning [Ying, interview].

According to Lisa, comparing the source text with different MT texts prompts her to *think* and *analyse* the semantic (meaning) and syntactic (form) features carefully, which in turn helps her better understand the source text. Similarly, *analysing* and *interpreting* the sentence structure of the source text and MT text enables Ying to increase her understanding of the source text. When evaluating MT output the students focus on the meaning of words and sentences and grammatical elements in both source and MT texts. They compare similarities and differences in meaning and form through reading back and forth between texts and languages, which contributes to language learning (Artar, 2018; Colina & Lafford, 2017; Giaber, 2018; Jiménez

[26] Chapter 5 (Section 5.2.2) specifies the five categories used for assessing student translations in pre-and -post interventions: source text meaning, situational appropriateness, grammar and mechanics, style and cohesion, and translation skills. Detailed information on the categories used for assessment appear in Chapter 4.

et al., 2015). This idea is reinforced by Cummins' (2007) argument that, in drawing explicit attention to similarities and differences between students' languages, efficiency in language learning can be enhanced.

The findings from SG1 and SG2 also show that using more than one MT tool for MT evaluation may amplify and draw students' attention to distinguishing the similarities and differences in meaning and grammar between different MT outputs. As shown by screen recording data in Table 5.4, for example, Lisa compared the translations of the English term 'performance-enhancing drugs' between Google output (*增強性能的藥物, performance-enhancing drugs*), Baidu output (*興奮劑, doping/stimulant*), and Youdao output (*提高成績的藥物, grades/performance-enhancing drugs*). Another example from the screen recordings (Table 5.8) shows that Amanda compared the translation of the English sentence 'He declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward' between Google output (*他拒絕進入 USADA 的仲裁程序，該程序導致該機構宣布將從 1998 年 8 月起剝奪他的所有獎杯和獎項, He refused to enter USADA's arbitration process. The arbitration process led the agency to announce that starting from August 1998, it would strip him of all his trophies and awards*) and Baidu output (*他拒絕參加 USADA 的仲裁程序，這導致該機構宣布，將剝奪他從 1998 年 8 月起的所有獎品和獎項, He refused to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 onwards).* Through consulting additional dictionaries, Lisa and Amanda were able to produce a translation that was closer to the source text. Similarly, some EMI postgraduate students in SG2 also recognised the usefulness of adopting two or more MT tools for cross-checking and evaluating MT output. For instance, Xiang indicated in the interview that she 'use[s] more MTs instead of just one', while Peng reported that he uses 'different machine translation tools to check, to have a cross-check'.

It can thus be argued that consulting different MT tools as a complementary strategy leads students towards purposeful comparisons of various MT outputs. This provides opportunities for them to notice nuances in meaning through comparing the form in different MT outputs because difference in form may result in a subtle to significant difference in meaning. The study reveals that using more than one MT tool serves to enhance students' judgements regarding MT accuracy and to generate appropriate translations through using two or more MT

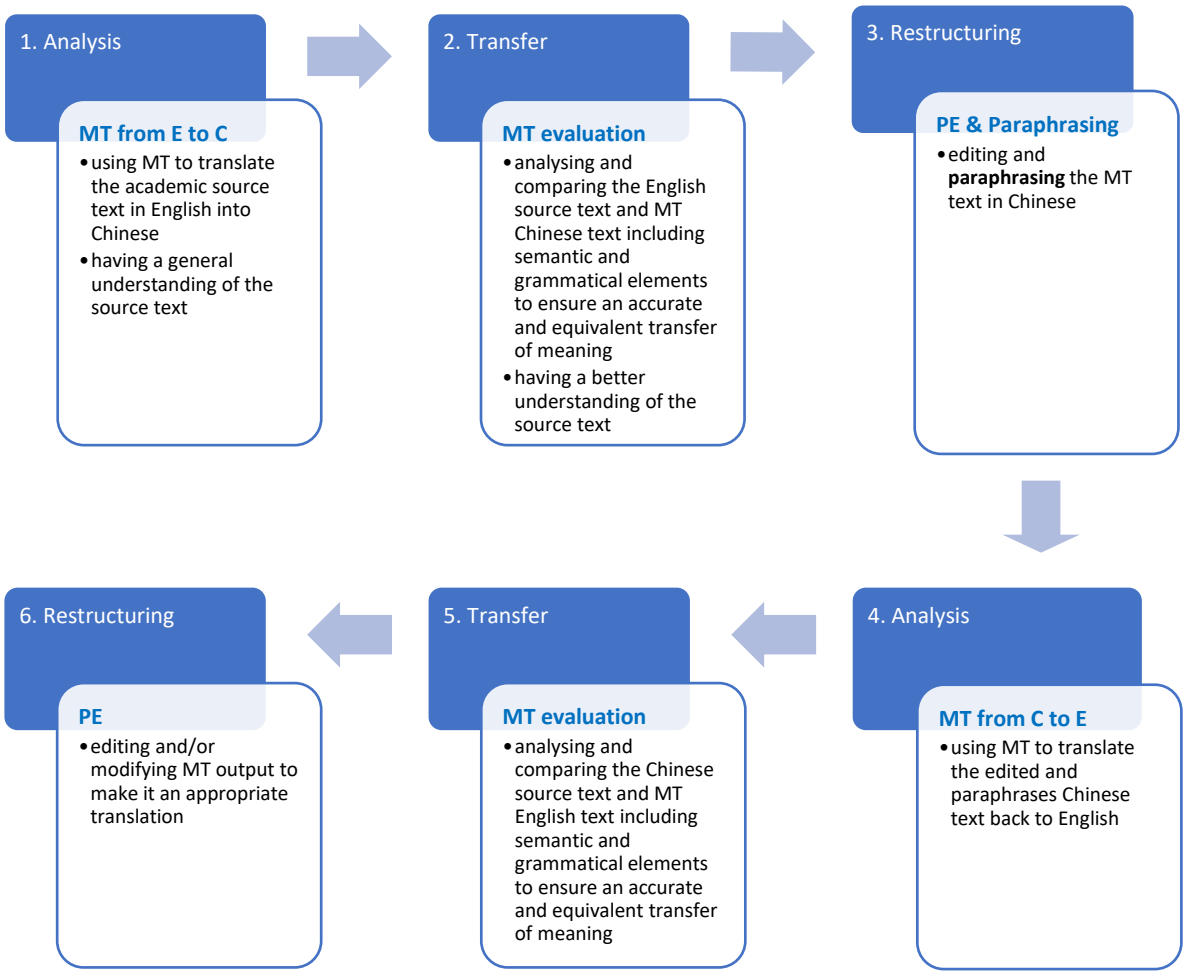
tools with complementary features. This aligns with previous studies that show language learners using multiple online-based resources as complementary strategies to enhance L2 accuracy and writing (Conroy, 2010; Lai & Chen, 2015; Yoon, 2016).

A relevant finding in relation to MT evaluation is that when students encountered inaccurate MT output, three (Amanda, Xiang and Lian) independently chose to edit the source text (pre-editing of MT input) for clarity of meaning and simplicity in form in order to increase the accuracy of the MT output. This use of MT is related to the use of controlled language in studies by Shih (2020b, 2022) and Zheng (2023) to reduce complexity and ambiguity of MT input so that MT output might be improved and efficiency in post-editing increased. Students in the present study made modifications to MT input using transparent vocabulary and grammar to replace lexis and syntax that lacked clarity or were likely to pose challenges for MT. Amanda, for example, received an inaccurate MT output '*一抽, a draw'* for the source text 'one smokes'. She subsequently edited the source text to 'one person smokes', and then she obtained an accurate MT output '*一個人抽煙, one person smokes'* (see Figure 5.11). This finding shows that pre-editing MT input not only requires students' capabilities in both languages but also the ability to analyse meaning and form between MT input and output. Students thus could strategically draw on their repertoires of languages in English and Chinese to make MT input transparent, hoping to improve the quality of MT output. Shei (2002) argues that 'pre-editing MT input can boost student learning…apart from training students to use MT' (p. 1). I therefore suggest that there is value in including pre-editing of MT input in translation-based pedagogy.

7.2.3 MT+PE as a strategy combination to support comprehension and paraphrasing

Findings in this study show that Lisa (with a postgraduate degree in Chinese Studies in SG1), Ying and Lian (EMI postgraduate students in SG2) all employ MT+PE to assist with paraphrasing in academic writing. Questionnaire and screen-recording data show that Ying and Lian use MT+PE to assist comprehension and paraphrasing when difficult English academic texts prevent them from understanding the content (see Section 6.1.4.2). Going beyond post-editing, Lian paraphrases the MT text in her own words (see Table 6.3 and Figure 6.6). I therefore discuss Lian's strategy in more depth using Nida's model of the translation process (see Figure 7.8 below).

[MT+PE: Translation from English to Chinese]



[MT+PE: Back translation from Chinese to English]

(Transfer and restructuring phases involve consulting tools, solving problems and making decisions)

Figure 7.8 Relating Nida's three-phase model to Lian's six step MT+PE process for comprehension and paraphrasing

In the analysis phase (student Step 1), Lian translated the challenging academic text in L2 English into L1 Chinese and obtained a general understanding of the source text, as shown in Table 6.3. In the transfer phase (Step 2), she analysed and compared the English source text with the MT Chinese text including semantic and grammatical elements to ensure an accurate and equivalent transfer of meaning. She may have consulted other HLT tools such as dictionaries when analysing the texts. For example, Lian found unnatural phrasing in the MT Chinese text where the English phrase 'buying…at unprecedented levels' was translated into Chinese '*以前所未有的水平购买, using unprecedented level buying…*'. Lian might have needed to use dictionaries to look up the meaning of the English word 'unprecedented' prior to

making decisions on how to edit the MT Chinese output, although she did not articulate this level of detail in reporting her process.

In the restructuring phase (Step 3), Lian edited and paraphrased the MT Chinese text. After completing the first three-phase process of translation (Translation from English to Chinese), she moved onto a second three-phase process of translation (Back translation from Chinese to English). She translated the edited and paraphrased MT Chinese text back to English using MT in the analysis phase (Step 4) and then went through the transfer phase (Step 5) and restructuring phase (Step 6) to complete paraphrasing.

Analysis of Lian's MT+PE processes suggests that Lian first gained a rough understanding of the source text through reading the MT output in Chinese in the analysis phase (MT from English to Chinese), and then she understood the source text more fully through conscientiously comparing and analysing the source text and MT text in the transfer phase (MT evaluation). This has similarity to Qing's two-step strategy of using MT to speed up reading followed by in-depth reading of the source text with the MT text. The in-depth reading increased the students' understanding of the difficult academic text in English and enabled the processing of subsequent activities such as paraphrasing the original text. The better understanding of the source text assisted Lian to edit and paraphrase into her own words in Chinese during the restructuring phase (PE and paraphrasing). Paraphrasing in Chinese also provided Lian with an opportunity to reword the text in her own words, which is considered to be important as it demonstrates the student's understanding of the source content. In the second round (using back translation), Lian translated her paraphrased text in Chinese back to English using MT (MT from Chinese to English), followed by the same transfer phase (MT evaluation), and restructuring phase (PE). The six-step process encompassing translation from English to Chinese and back translation from Chinese to English helped Lian complete paraphrasing involving source text reading comprehension and reconstruction (Hirvela & Du, 2013; Shi, 2012; Shi & Dong, 2018). This process, particularly in the transfer and restructuring phases, requires the student to consult tools to find answers to linguistic enquiries in transferring meaning from English to Chinese and vice versa, and to make decisions on how to edit and rephrase the MT text to finish paraphrasing.

Comparing the Chinese language students' translation processes with the EMI postgraduate students' paraphrasing processes reveals the complexity of paraphrasing in L2. Whereas translation from one language to another requires one round of the translation process,

paraphrasing in L2 needs two rounds of the translation process, i.e., translation and back-translation. This is because paraphrasing is the rewriting of sentences in a new structure but retaining the original text meaning within the same language, as explained by Widdowson (2014) as intralingual textual reformulation and by Jakobson (2021) as intralingual translation or rewording. Thus, when the original text in L2 is difficult to understand and paraphrase, the EMI postgraduate students need to carry out translation from L2 English to L1 Chinese followed by back translation from L1 Chinese to L2 English. This finding further confirms that paraphrasing is complex and challenging for L2 writers in both cognitive and linguistic processes (Hirvela & Du, 2013; Shi & Dong, 2018; Yamada, 2003). This explains why Lian employed MT+PE twice to first understand and rewrite the source text and then translate it back to English, and why Xiang's use of MT to 'paraphrase' the source text (see Figure 6.7) might be problematic because she might not fully understand the source text.

In her paraphrasing process, Xiang did not include the steps of comparing the source text with the MT text (MT evaluation) and editing and paraphrasing in L1 (PE and paraphrasing). Without the two steps to understand the original text more fully, she could still generate a paraphrased text. Her paraphrased sentences, however, retained a sentence structure that had a high degree of similarity with the source text. Xiang's strategy meant that she was at risk of leaning towards what could be regarded as plagiarism. However, through the collaborative MT and PE tutoring process, this student recognised the problem with her paraphrasing strategy. This points to the potential need and value of incorporating MT and PE into language pedagogy and curricula in higher education institutions (HEIs) to guide multilingual learners, particularly EMI students who are required to draw on L2 English academic texts, on how to make appropriate and effective use of MT and PE to support academic reading and writing.

The findings also complement and add to Trenkic and Warmington's (2019) work in the UK showing that Chinese international students with an average IELTS score 6.92 [27] are at academic performance disadvantage compared with their English L1 peers. This is due to their smaller vocabulary in English, being less able to understand and summarise academic learning materials and requiring twice as long to read academic texts in English. The findings of the

[27] IELTS score requirements for undergraduate international students in most Australian universities is at an overall 6.0 score, and an overall 6.5 score for postgraduate international students. These scores are lower than the average 6.92 score in Trenkic and Warmington's (2019) UK study.

present study, therefore, have implications for how English-dominant HEIs can best support EMI students. HEIs often have services that provide academic study assistance to students in general, and international students in particular. In addition to existing services, English-dominant HEIs may need to include explicit provision of or embedding teaching of MT and PE in the study programs for EMI students who may need to use MT and PE to enhance their academic use of English. At non-English-dominant HEIs, EMI programs often include English courses such as English for Academic/Specific Purposes to cater for EMI students' English development (Tsou & Baker, 2021; Tsou & Kao, 2017a). Nonetheless, the English language courses in these institutions may be strengthened with the integration of MT and PE pedagogy to offer better support for EMI students through appropriate human-machine interaction. As this study shows, students appear to have a better understanding of how to use MT appropriately to support their academic study while maintaining academic integrity after engaging in a pedagogical intervention that includes learning how to use MT and PE. How far this may contribute to language learning and content knowledge acquisition is discussed further below.

7.2.4 MT and PE expanding cognitive skills and linguistic capabilities

As indicated in the previous sections, MT is used as a resource in students' HT processes and MT+PE is adopted as a strategy combination to facilitate translation in either Chinese language learning contexts or EMI postgraduate study contexts. When consulting MT, students are required to draw on their available repertoires of languages and resources to evaluate MT accuracy prior to deciding whether to accept MT output or edit it to suit their purposes. The use of MT and PE, in this sense, demonstrates human-machine interaction, or Salomon et al.'s (1991, p. 3) 'intellectual partnership' between learners and technology. The students in this study use their linguistic repertoires and cognitive skills with HLT tools to support meaning making and meaning transfer from Chinese to English and English to Chinese. Students' translation or written production is generated by the 'joint effort' between themselves and machines (Salomon et al., 1991, p. 3). Apart from Xiang's 'paraphrasing' example, the students go through complex cognitive and linguistic processes and apply their own language knowledge (human intelligence) to evaluate and post-edit MT output (machine intelligence), in consultation with additional HLT resources. This shows that the human-machine partnership differs from simply using machines to work for humans, but instead it is for humans to work *with* machines to achieve a better learning result (Salomon et al., 1991). As demonstrated above, this partnership not only requires but also further expands humans' cognitive skills and

linguistic capabilities. This, therefore, indicates that there is reason to suggest that MT use involves far more than cutting corners, and that MT may be a valuable AI tool to support the processes of learning language and gaining access to knowledge, if used appropriately.

As presented in Chapters 5 and 6, most student participants when engaged in their own HT processes had already made use of MT in various ways, prior to the start of this study. However, students became more alert to the dynamics of MT and PE when deliberative sensitisation interventions were initiated. Students exhibited a raised awareness of how to use MT appropriately through learning how to use MT and PE during and after these interventions (see Sections 5.2.5 & 6.2.5). The findings suggest that a strong argument can be made for the advantage of and potential need for an explicit pedagogical intervention in which complementary HT, MT and PE strategies are integrated for purposes of learning language and accessing content knowledge in higher education. They also suggest that not only translation students but also language students and EMI students require clear guidance on the use of HT, MT and PE as complementary strategies. As Jonassen (1992) puts it:

> Technologies do not directly mediate learning. That is, people do not learn from computers…or the other devices that were developed to transmit information. Rather, learning is mediated by thinking (mental processes). Thinking is activated by learning activities, and learning activities are mediated by instructional intervention, including technologies (p. 2).

In this study, teaching interventions for SG1 and SG2 involving learning activities related to HT, MT and PE have been shown to activate students' broader range of linguistic repertories while stimulating their cognitive processes of moving back and forth between texts and languages to evaluate MT accuracy and post-edit MT output. These learning activities prompted students to recognise that MT cannot replace their own cognitive engagement and effort, but instead MT together with PE can serve as resources and strategies to facilitate their cognitive processes of language learning and knowledge acquisition. The intervention activities involving HT, MT and PE have been shown to extend students' cognitive skills and linguistic capabilities through interactions between humans (students) and machines (MT and other HLT tools). These translation activities provided students with opportunities to exploit human intelligence and artificial intelligence at their disposal to maximise their learning. Put simply, students' learning was mediated through the cognitive processes involved in the translation activities designed in the teaching interventions. According to Jonassen (1992), machines or computer-based tools function as 'cognitive tools' to mediate cognitive processes

and skills. Learners' cognitive processes and skills can be augmented when learning *with* computer-based tools or technologies:

> Learning with technologies amplifies the learner's cognitive processes while using those technologies. Computer-based cognitive tools are in effect cognitive amplification tools…Cognitive tools are intelligent resources with which the learner cognitively collaborates in constructing knowledge. (Jonassen, 1992, p. 3)

This study indicates that when students are learning how to use MT and PE through translation activities, they simultaneously expand their cognitive skills in decision making, problem solving, and the use of HLT tools to access information and knowledge. These are critical elements of autonomous learning and developing learner autonomy (Lai & Chen, 2015; Niño, 2020; Yoon, 2016). As Maggie stated in the interview, 'I now better understand how to use MT and in what context I would like to use', while Lisa said, 'I know which method to use in which situation'. Likewise, Qing indicated in the interview, 'if I need to get help…I know where I can find the assistance'. These student remarks suggest that developing capabilities in MT and PE may support the development of learner agency, which Palfreyman and Benson (2019) view as an essential component and a starting point of developing learner autonomy. Gao and Yang (2023) argue that it is important for language teachers to foster learner agency and prepare students to become autonomous learners.

Furthermore, the findings related to students' translation processes in this study support earlier research on the relationships among the use of students' multilingual repertories, translation, and developing multilingual capabilities in reading and writing (Colina & Lafford, 2017; Cook, 2010). The present research further reveals that the students not only use their own linguistic repertoires and cognitive abilities but also MT and other HLT resources to analyse and understand texts (in the analysis phase), to make a transfer of meaning corresponding to the target language and culture (in the transfer phase), and to restructure translated texts to render appropriate translations (in the restructuring phase). Translating between languages, has long been regarded as a pedagogical approach that aids language learning (e.g., Cook, 2010, 2018; Pintado Gutiérrez, 2021). It is also regarded as a practice that is included under the umbrella of a relatively recent pedagogy and theory of translanguaging (e.g., Heugh, 2021; Wei & García, 2022). In the discussion below, I argue that MT may facilitate students' translanguaging processes and increase opportunities for multilingual learning.

7.3 Implications of MT and PE: Human-machine interaction in translanguaging

Whereas theoretical conceptualisation and debates about translanguaging vary depending on the contexts in which and purposes for which the term is used, the key aim behind translanguaging is the utilisation of learners' entire set of linguistic and semiotic resources to leverage learning and to understand and make meaning (Leung & Valdes, 2019; Lin, 2019; Thomas et al., 2022; Tsou & Baker, 2021; Wei, 2022; Wei & García, 2022). In this section, I consider MT and PE through the lens of translanguaging to understand implications for multilingual learning and pedagogy, multilingualism, and academic integrity.

7.3.1 Purposeful use of MT enhancing multilingual learning and capability

As discussed earlier, findings from SG1 and SG2 reveal multilingual learners' five purposeful uses of MT, which could be divided into two categories: using MT as a multilingual dictionary and using MT as more than a dictionary (see Figure 7.9).

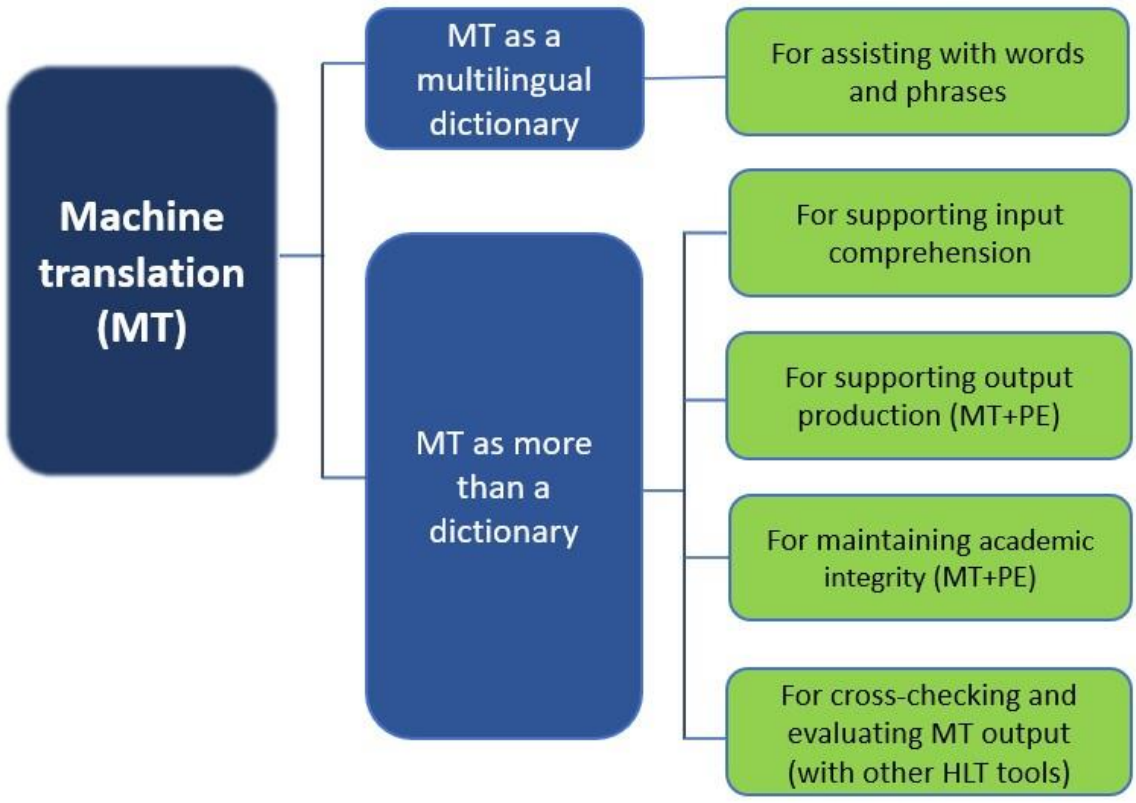


Figure 7.9 Multilingual learners' five purposeful uses of MT

The students from both groups use MT as a multilingual dictionary to assist with words and phrases for reading and writing. Lisa, for example, used MT (Google Translate) as a

multilingual dictionary to make a three-directional translation (English-Dutch, Dutch-English, English-Chinese) to understand the meaning of the English word 'stultify' (see Table 5.10). Together with the use of the Pleco dictionary app, she then found a close equivalent in Chinese. As a multilingual speaker, Lisa draws on her repertoire of languages (L1 Dutch, English, Chinese, and possibly French in her mind), various HLT resources (e.g., MT and Pleco), and her cognitive skills (e.g., reasoning and interpreting) to understand meaning in English and then determine how to convert the meaning into Chinese.

In relation to using MT as more than a dictionary, students in this study employ MT to translate larger language units (e.g., sentences and paragraphs) to support L2 input comprehension, including checking comprehension of reading texts, and speeding up reading to search for materials for in-depth reading, as discussed in Section 7.1.1. They use MT to support L2 output production, including checking own written production and assisting with revision, as specified in Section 7.1.2, and utilising MT+PE to support a transfer of meaning from one language to another for increasing accuracy of written production, as indicated in Sections 7.1.3 and 7.2.2. As such, MT+PE is also adopted as a strategy combination to assist paraphrasing, as discussed in Section 7.2.3. Using MT and PE to support paraphrasing and/or summarising seems to help students maintain academic integrity, which is discussed in Section 7.3.3. Finally, the students use MT itself to cross-check and evaluate MT output, including using more than one MT tool together with additional HLT resources and pre-editing MT input, as demonstrated in Section 7.2.2.

As MT can translate large language units, the students exploit MT to check MT output. Most of the student participants come to use two or more MT tools in combination with their preferred HLT resources to evaluate MT accuracy after the interventions. For example, screen recording data show that Lisa adopted three MT tools to cross-check the MT Chinese output '*铁人三项比赛, triathlon competition'* and also accessed Google Image to double-check the meaning of this Chinese term (see Table 5.4). Similarly, Maggie stated in the interview, 'I will use MT and then put the translation on Google Image to see if it is correct'. The two data sources show that the students employ their repertoires of languages and semiotic resources (e.g., images and pictures) to understand and make meaning. The findings indicate that language encompassing separate linguistic codes and visual semiotics constructs an integrated system to support students in meaning making and gaining understanding (Canagarajah, 2011; García & Wei, 2014; Lin, 2019; Tsou, 2021). Linguistic codes generated by MT and semiotic

resources from Google Image serve as part of students' resources for learning of language and knowledge.

In this study, students use MT as a resource and MT+PE as a strategy combination, for which they consult additional HLT tools to evaluate MT accuracy, solve linguistic problems, and make decisions about how to edit or modify MT output to suit their purposes and increase the greater accuracy of their translation. These MT and PE capabilities appear to be developed and strengthened through the interventions involving translation activities. As shown in this study, learning how to use MT and PE seems to help advance students' language learning and access to content knowledge through five interrelated processes. These are: increased efficiency in reading, accuracy in text comprehension and production, opportunities for learning vocabulary and grammar, confidence in learning, and awareness of appropriate use of MT. The findings align with previous research demonstrating that alternating use of two languages for input and output activities in the classroom can enhance multilingual capability and content knowledge acquisition simultaneously (Baker & Wright, 2021; Cenoz & Gorter, 2021; Heugh, 2018; Lewis et al., 2012). The findings of this study draw closer attention to the potential of MT and PE in students' translating and meaning making processes. Because students are likely to encounter varying degrees of difficulty when translating and interpreting texts, they can (and do in this study) use MT and PE to solve linguistic problems and facilitate learning processes.

As such, I suggest that recognition and understanding of students' purposeful use of MT expands and contributes to current literature on translanguaging. I argue that MT and PE could be regarded as falling under the umbrella of translanguaging practices. As Ortega (2017) puts it:

> …digital communication, very much like translanguaging in action, is carried out by assembling whatever bits of semiotic repertoires: It is always an amalgam of multisensory and multimodal linguistic and nonlinguistic signs, and it rarely results in one-language-only or one-language-at-a-time texts. (p. 294)

Tsou (2021) also considers translanguaging as embracing verbal and non-verbal forms and various modalities of communication, including the use of digital resources. In digital communication, particularly written communication, MT and PE are resources and strategies that have the potential to enable or permit students to make use of their whole linguistic repertoire, as well as a range of semiotic resources and cognitive skills for making meaning and gaining understanding of information and knowledge.

7.3.2 Translanguaging and transknowledging towards multilingualism

As indicated above, over the last 15 years, the literature of translanguaging, while including translation under its umbrella, has primarily focussed on spoken practices of linguistic border crossing (e.g., Lin, 2019; Wang, 2019). Here, I draw attention to the more formal practice and use of translation for high level academic purposes that requires recognition of the distinctions between two or more languages. The discussion of the data from this study below builds on earlier discussions of translation under the umbrella of translanguaging, and also a more recent discussion of transknowledging (Heugh, 2021).

The findings from SG1 and SG2 show that students apply MT+PE as a strategy combination to support the transfer of meaning from L1 to L2. Specifically, when students find it difficult to express meaning in the L2, they write in the L1 to clarify their thinking and then use MT to translate into L2 followed by the process of PE, as indicated by Rory, Qing and Xiang in interview. This indicates that students' L1 enables them to engage in higher order thinking and to express greater clarity and precision for intended meaning and ideas. The L1 of students serves as a *cognitive and linguistic tool* to assist them to express meaning more precisely. Following the organisation of thoughts with L1, using MT to translate L1 into L2 and then undertaking PE allows the students to ensure an appropriate transfer of meaning from L1 to L2 and to increase translation accuracy. Analysis of this finding suggests that students' L1 and other familiar languages may serve as *scaffolding functions* to support learning (see also Tsou, 2021; Tsou & Baker, 2021), especially when they have not developed adequate academic language capabilities in the L2. Scaffolding is 'like a bridge used to build upon what students already know to arrive at something they do not know' (Benson, 1997, p. 126). This study shows that students from both groups draw on their multilingual and semiotic resources and existing knowledge to enhance their learning of the target language and content knowledge. The students make use of their stronger languages and prior knowledge to bridge the gap in weaker languages and unfamiliar knowledge. This is in line with Cook's (2018) argument:

> Connecting new to existing knowledge, and using the latter to make sense of the former, is a universal and productive human learning strategy (p. 289).

This study further reveals that MT and PE help students connect repertoires of language and knowledge more effectively. With the aid of MT and PE students are better able to build on their existing language(s) and knowledge to learn and expand their developing language and knowledge. This is justified by the findings in relation to students' purposeful use of MT and the interrelated processes through which students enhance their language and content

knowledge learning. I therefore argue that translation or translanguaging expands and extends with the use of MT and PE. MT allows students to use their multilingual capability more fully to help with learning through translation or translanguaging (Chen et al., 2019) and MT+PE makes meaning transfer between languages more effective (Daems et al., 2017; Jia et al., 2019; Yamada, 2019).

The notion of translation expanded with MT and PE appears to amplify Heugh's (2015, 2018, 2021) discussion of 'vertical translanguaging' found in academic and formal written translation contexts. Such contexts require precision and equivalence of meaning between parallel separated linguistic systems and high level multilingual proficiency (Heugh, 2018, 2021). Access to higher education requires high level capability in at least one language for students who speak one of a handful of internationally used languages, and at least two languages for the majority of students globally. In this study, both Chinese language students and EMI postgraduate students require high level capability in at least two languages. Students in both groups engage in formal written processes of translation between different language systems (Chinese and English) to assist with understanding learning content and completing learning tasks for academic study purposes.

The students strategically use MT and PE to support L2 reading and writing in order to understand learning materials (source texts) more fully and to generate appropriately written assignments (target/translated texts). Their written texts are thus a product of vertical translanguaging practices in which students navigate translation processes back and forth between two (or more) language systems. This finding is in line with Ortega's (2017) argument that communication with digital technology 'rarely results in one-language-only or one-language-at-a-time texts' (p. 294). The students in this study ultimately work with at least two languages to produce sophisticated one-target-language texts through a complex translingual process with the use of MT and PE. The finding also reinforces Heugh's (2018, 2021) argument that whereas 'horizontal translanguaging' used for convivial spoken purposes involves fluid 'mixing' and 'crossing' of conventional language boundaries, vertical language hierarchies and distinct boundaries between languages are retained for high-stakes purposes, including higher education. This is particularly where the objective includes advanced (bilingual or multilingual) achievement. However, the translation of texts involves more than translanguaging processes. It also involves exchange and translation of two or more knowledge systems, i.e., the student's existing knowledge system(s) and the new knowledge system. This is referred to as 'transknowledging' (Heugh, 2021; Heugh, et al., 2022; Windle, et al., 2023).

Students connect their prior language(s) and knowledge to the developing language and knowledge in the process of translanguaging and transknowledging, through which they are likely to acquire knowledge and develop academic language capability in both languages.

The argument here is that MT and PE can facilitate students' translanguaging and transknowledging processes and, particularly for EMI students, increase successful learning opportunities in higher education institutions (HEIs). As shown in this study, without the aid of MT (before the intervention), when the EMI postgraduate students encountered difficult study materials, they were effectively prevented from accessing the information and thus disadvantaged (see Section 6.1.2.2). This would then limit or prevent students from engaging in summarising and paraphrasing activities in academic writing. Inadequate academic language capability and expertise in the use of MT appear to compromise student confidence in learning (see Sections 5.2.4 & 6.2.4), and to place students at risk of plagiarism, as shown in Xiang's paraphrasing strategy in Figure 6.7. These issues may consequently risk students dropping out or being forced out of their academic study in HEIs.

Through learning to use MT and PE the Chinese language students find that MT helps them gain 'a sense of safety' [Lisa, interview] and overcome their 'lack of Chinese capabilities' [Amanda, interview]. Similarly, the EMI postgraduate students believe that MT helps them 'gain confidence' [Yun, interview] and can be a useful resource for students with 'lack of confidence of their own writing' [Ying, email correspondence]. More importantly, both groups of students raise awareness of how to make critical and judicious use of MT during and after the interventions. These findings show evidence that learning to use MT and PE can facilitate students' translanguaging and transknowledging processes. This in turn may contribute to more successful and positive learning experiences in HEIs.

As such, I suggest that language pedagogy and curricula for multilingual learners in both contexts of language learning and teaching and also in EMI can be enriched with translation or translanguaging where this includes MT and PE, so as to benefit HEI students. Learning activities that involve HT, MT and PE and focus on the use of these three as complementary strategies in learning how to use MT and PE appear to be helpful for students, as indicated in this study. Students start with HT and then switch to MT and PE when needed. This human-machine interaction can be related to and amplify what Sierens and Van Avermaet (2014) have called 'functional multilingual learning', in which students' whole linguistic repertoire is used as:

> didactic capital…to foster personal development and increase their chances of educational success. The first language may serve as a stepping stone to the acquisition of the second language and the learning of new content (p. 217).

Functional multilingual learning not only involves translanguaging but also treats multilingualism as a pedagogical tool and scaffold to support learning of language and new knowledge (French, 2019; Slembrouck & Rosiers, 2018; Slembrouck et al., 2018). In this study, the students from both groups utilise their multilingual capability, existing knowledge, MT, and additional HLT tools as resources to search for information, gain understanding of learning materials, clarify thoughts, organise ideas, and express intended meaning. Their translanguaging and transknowledging practices include strategic use of MT and PE, through which the students maximise their multilingual repertoires and knowledge systems and gradually achieve high level multilingualism.

Moreover, preparing multilingual learners such as language students and EMI students so that they have equal opportunities to gain access to information and exchange knowledge in HEIs also contributes towards a more inclusive, equitable and socially just education. García et al. (2017) point out that it is educators' responsibility to ensure that 'all students…understand challenging content and texts…Translanguaging enables educators to more equitably provide opportunities for students to engage with complex material' (p. 8). In addition to translanguaging, students can contribute to reciprocal exchange of knowledge and learning among peers and teachers through transknowledging. Heugh (2021) therefore argues that purposeful use of translanguaging together with transknowledging are two foundations for providing best opportunities for equality:

> Multilingual education anchored in systematic use of translanguaging and transknowledging offers students education that sustains knowledge and language diversity, and equalises opportunities beyond school education. (p. 45)

In the multilingual world with advances in digital technology, it may be more valuable to view multilingual learners' repertoire of languages as an integrated resource and to understand how they work with technologies to support their multilingual learning processes. Learning how to use MT productively for efficient and effective learning while increasing opportunities for learners to expand their language and knowledge resources is an opportunity for HEIs. It may well become beneficial for anyone wishing to pursue and exchange knowledge in a language other than their first.

7.3.3 Academic writing and academic integrity

English academic writing with source texts is challenging not only for multilingual learners (Hirvela & Du, 2013; Shi & Dong, 2018) but also for multilingual researchers (Zheng & Guo, 2019). Writing with source texts usually requires writers to engage with complex internal metacognitive interpretation of academic articles, followed by paraphrasing or summarising this in the L1 before translating the paraphrase or summary back into L2 (Heugh et al., 2022). In this study, students from both groups consider that MT and PE are helpful for supporting academic writing in the L2 and that their use is not related to a breach of academic integrity (see Sections 5.1.2.5 & 6.1.4). Lisa indicated in the interview that 'plagiarism is hard to avoid' so she adopted MT+PE to assist paraphrasing the ideas of original authors. Similarly, Amanda and Rory believe that understanding how to use MT and PE might 'motivate them [students] not to plagiarise' [Amanda, interview] and 'reduce the motivation for cheating…Because they don't need to do so, they could write in their native language and then use [MT+PE]' [Rory, interview].

Screen recording (see Figure 6.4) and interview data (see Section 6.1.4.1) show that Yun employed HT, MT and PE to complete her academic writing of summaries. The sequence of Yun's summarising process comprised six steps (see Figure 7.10). First, Yun summarised several English academic papers in L1 Chinese. Second, she translated the summary from Chinese to English by herself (HT). Yun, however, was not sure about the accuracy of her own translation generated by HT so decided to use MT to compare with her HT output. As her third step, therefore, she used MT to translate her HT output in English into Chinese for examining whether what she wrote in English was equivalent to her intended meaning. She also evaluated MT accuracy at this step. Fourth, to convey her intended meaning she post-edited (PE) unsuitable MT output in Chinese. Fifth, Yun used MT to translate the post-edited Chinese text back to English to obtain MT English output. Sixth, she compared her own HT text with the MT English output from a sequence of MT-PE-MT translation to make further revisions. In so doing, she identified incorrect syntax in her HT text and revised and repaired the inaccuracy.

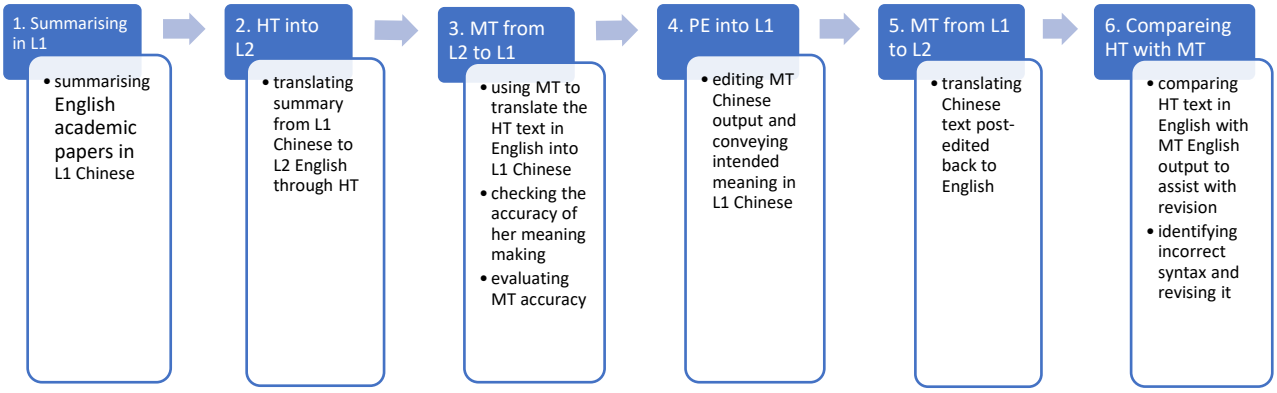


Figure 7.10 Yun's six-step summarising process with HT, MT and PE

Analysis of Yun's summarising process shows that she has drawn on her repertoire of languages in Chinese and English to read academic articles in L2 English, to summarise the information in L1 Chinese, and then to translate this into L2 English. This sequence offers insight into the complexity of her translanguaging practices, i.e., alternating use of two languages for input and output activities (Baker & Wright, 2021; Cenoz & Gorter, 2017; Lewis et al., 2012). L1 served as a *cognitive and linguistic tool* for thinking, which helped Yun engage in the first cognitive and linguistic activity, summarising. She then continued with the second cognitive and linguistic process, translating. MT and PE were involved in the translation practice from the third to the sixth step to assist with revision and improving the summarised text in L2 English. This demonstrates that Yun employed her repertoire of languages, prior knowledge, MT, and cognitive skills to move back and forth between two language systems, for checking the accuracy of meaning and syntax in her own English writing, conveying her intended meaning in L1 Chinese, and comparing HT and MT outputs for making modifications. Yun drew on multilingualism and translanguaging or what García and Leiva (2014, p. 199) call 'an act of bilingual performance' to complete academic reading and writing activities.

While Yun used MT and PE to support HT, important in this MT assisted revision process are the sub-steps of evaluating MT output and checking the accuracy of her meaning making at Step 3, as well as PE into L1 Chinese at Step 4. As far as can be ascertained through a close reading of available literature on MT in language teaching, this is a matter that has not previously been fully identified or discussed. Checking if what was written equates to what was intended, followed by PE into L1 Chinese, enabled Yun to fully convey her intended meaning and to reconsider her word choice. Subsequently, Yun translated the post-edited Chinese text back to English to obtain MT output in English. This is particularly important given that the student intended to compare her HT text in L2 English with MT English output

to make revisions. This six-step process not only pushed the student to reflect on her meaning making and meaning transfer between English and Chinese, but it also helped her identify grammatical inaccuracies in her own HT text.

In addition to Yun's summarising strategy, another remarkable example is Lian's strategy of using MT+PE to support understanding and paraphrasing more difficult academic texts. As discussed in Section 7.1.3, Lian drew on her linguistic capabilities in Chinese and English to undertake a six-step MT+PE process to gain a better understanding of the academic text in L2 English, to paraphrase in L1 Chinese, and to produce an appropriate and comprehensible paraphrased text in L2 English (see Figure 7.8). This process not only required Lian's repertoire of languages and MT resources, but also her existing knowledge and cognitive skills to compare and evaluate between L1 Chinese and L2 English. Both Yun's and Lian's examples display complexity of metacognitive and metalinguistic processes. This explains why Yun believes her MT use should not be linked to problems of academic integrity:

> …we don't just copy and paste…we still double check if that [MT output] is what we want to express and modify our own writing, hence it's still our own work [Yun, interview].

One thing in common in the two students' translation processes is that when they received MT output in L1 Chinese, they post-edited the MT Chinese text according to their needs and purposes. In Yun's case, she revised the MT Chinese text to express her intended meaning; in Lian's case, she rewrote the MT Chinese text to reduce the similarity to the source text. This means MT Chinese output helped them revise or reword the text in their own words in L1 Chinese. Neither student directly copied and pasted MT output into their written texts. Instead, they worked with MT and included their own translation and MT output through the process of PE to generate their perception of appropriate translations.

These findings may help HEI policy makers, educators and even students themselves to understand the complex metacognitive and metalinguistic processes of summarising and paraphrasing. The implications of the findings for multilingual pedagogy particularly in supporting academic writing are discussed in Chapter 8.

7.4 Chapter summary

In this chapter, drawing on students' purposeful uses of MT and processes of PE, I have discussed the potential of MT and PE through three theoretical lenses: SLA, translation, and translanguaging. Section 7.1 focused through the lens of interactionist SLA theory on how

students use of MT and PE to make input and output comprehensible can help language learning and acquisition. This human-machine interaction through using MT and PE entails both meaning-focused and form-focused learning, through which students draw on their broader range of linguistic repertories, cognitive processing skills, and additional HLT tools to make meaning, gain understanding, and learn language.

In Section 7.2, I examined the role and function of MT and PE in students' translation processes using Nida's (1969) three-phase model of the translation process. This shows MT and PE serving as resources and strategies that students use to analyse and understand the source text (analysis phase), make a transfer of meaning corresponding to the target language and culture (transfer phase), and restructure, edit and/or modify the translated texts to produce appropriate translations (restructuring phase). Learning how to use MT and PE through the teaching interventions provided students with opportunities to activate their multilingual capabilities, cognitive abilities, and skills of consulting tools, solving problems, and making decisions. This enhanced both language learning and content knowledge acquisition.

Section 7.3 focused on the implications of MT and PE for student learning through the lens of translanguaging. MT and PE function as scaffolds to mediate between students' language and knowledge systems, while translanguaging and transknowledging allow students to maximise their multilingual repertoires and semiotic resources that leverage learning of language and knowledge. Expertise in MT and PE clearly offers multilingual learners opportunities for equalising access to academic knowledge and thus supporting social justice, while the affordances of MT and PE in maintaining academic integrity may need closer attention before clear conclusions can be reached. Nevertheless, this study shows that all students raised their awareness of critical and judicious use of MT during and after the pedagogical intervention.

8 Conclusion

Translation serves to mediate exchange of meaning between languages or between texts in different languages. When humans (students in this study) have difficulty in making meaning in L2 or making a transfer of meaning from one language to another by themselves through human translation (HT), they may need assistance of human language technology (HLT). In Chapter 1, I locate HLT, including online machine translation (MT), as one of the prominent foci of attention in the early exploration of AI, which has been applied across many aspects of human life, including language education. MT, one of the applications of HLT, is becoming a common tool for many multilingual learners in different higher education contexts. These multilingual learners include, but are not limited to, language students whose purpose is to advance their study of the target language (the L2) and students who are studying a degree through English medium instruction (i.e., EMI students). The purpose of EMI study is to acquire discipline-based content knowledge whilst also anticipating a simultaneous strengthening of L2 capabilities in English.

However, students' use of MT often raises concerns about their L2 development and its association with academic integrity. Previous studies show that teaching staff believe that whether using MT relates to academic misconduct depends on how it is used and in what context; however, only limited research has focused on how students use MT. While skills in MT and post-editing (PE) of MT generated text have been considered important for translation students and multilingual researchers, few studies have paid attention to the development of expertise in MT and PE in L2 teaching and EMI contexts, despite the reality that many language and EMI students have used MT in their studies.

Therefore the core aim of this study was to investigate the potential of MT and PE to advance L2 learning in both language learning and teaching and EMI contexts. More specifically, I sought to understand how MT is used by multilingual learners, particularly how they can use MT to help mediate the equivalence of meaning between languages to support their L2 learning. I also wished to understand whether MT and PE could serve to advance L2 learning in both contexts. Two research questions were then formulated:

1. *How do multilingual learners use MT to support their L2 learning?*

2. Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?

As indicated earlier, the outbreak of COVID-19 and travel bans in 2020 resulted in a change to my original research design. On-site face-to-face teaching shifted to online delivery via Zoom. The first student group (SG1) comprised four advanced level students of Chinese at National Taiwan University, and the intervention for SG1 involved HT, MT and PE in an online pilot English-Chinese translation course. The second student group (SG2) comprised six Chinese-speaking students who were studying postgraduate degrees through EMI at the University of South Australia. The intervention for SG2 was mostly[28] carried out through an online MT and PE collaborative tutoring process. This involved HT, MT and PE, and focused on using the three complementary strategies to support postgraduate studies. In short, translation was used as a pedagogical approach for both groups, and both groups had L2 proficiency at CEFR B2/C1 levels. I expected that the study of the two student groups (Chinese language students and EMI postgraduate students) could help me gain a deeper understanding of the potential of MT and PE and their pedagogical use.

To this end, I undertook an adapted five-phase procedure of action research, comprising planning, implementation, observation, reflection, and reflexivity and praxis. I adopted triangulation of multiple research methods to collect data from different perspectives, hoping to gain rich data and insights for the study. The collected data consisted of pre- and post-intervention questionnaires, screen recordings, focus group interviews, and email correspondence for a follow-up enquiry. Because the intervention for SG1 was undertaken in a translation course, students' translation samples for the pre- and post-intervention tasks were collected for assessment. Reflection-in-action, reflection-on-action, and reflexivity of the teaching intervention for SG1 helped me to make modifications to the planned intervention for SG2. Having recognised interrelationship and complementarity among the use of HT, MT and PE in SG1, I explored this further with SG2.

Through the meta-analysis of the combined findings from the two groups using the theoretical lenses of second language acquisition (SLA), translation, and translanguaging, I have gained a better understanding of students' purposeful use of MT and process of PE and how learning to use MT and PE can advance learning of both language and content knowledge. The findings

[28] The MT and PE collaborative tutoring was conducted face-to-face for the first session and then changed to online teaching for the remainder of sessions in compliance with the university's COVID-19 regulations.

of this study offer new insights to extend earlier discussions of SLA, multilingualism, and EMI in higher education; they also clarify some ambiguities in previous research. I highlight key contributions of the main findings and the significance of this research in Section 8.1. These include the identification of multilingual learners' five purposeful uses of MT to assist L2 input comprehension and L2 output production, the nature of MT and PE capabilities, and five interrelated processes that advance learning of language and knowledge. Subsequently, I make concluding reflections on the teaching interventions and some key findings of this study in Section 8.2. Following reflection, the limitations of this study are identified in Section 8.3. Some recommendations for future teaching practices and further research are put forward in Section 8.4.

8.1 Key contributions and research significance

The contributions of the main findings and their research significance are as follows: multilingual learners' five purposeful uses of MT, what MT and PE capabilities involve, how MT and PE can advance learning of language and knowledge through five interrelated processes, and MT and PE facilitating multilingualism.

8.1.1 Multilingual learners' five purposeful uses of MT

The findings of this study in relation to RQ1 (How do multilingual learners use MT to support their L2 learning?) identify five purposeful uses of MT across the participating students (see Figure 8.1, an extension of Figure 7.9). These purposeful uses encompass two areas: using MT as a multilingual dictionary and using MT as more than a dictionary, because MT can translate larger language units such as sentences and paragraphs. When adopting MT as a multilingual dictionary, students' strategies are twofold: using MT to 1) look for meanings and translations of words or phrases; and 2) understand the usage of words or phrases by looking at sample sentences provided on the tool. The other four purposeful uses of MT involve MT as more than a dictionary, the first of which is to support L2 input comprehension. Students' strategies in this regard involve using MT 1) to speed up reading to locate learning materials for in-depth reading; and 2) to check L2 reading to confirm or increase comprehension. The remaining three purposeful uses of MT relate to output. First is using MT to support L2 output production, with associated strategies as follows: 1) using MT to check their own L2 written production (HT output) to ensure the accuracy of meaning making and grammar in their L2 writing and to assist with revision; and 2) using MT+PE to facilitate translation or convey the intended meaning for increasing appropriateness of written production. Still focusing on L2 output is the fourth

purposeful use of MT, which is to support summarising or paraphrasing in academic writing to help maintain academic integrity. Their strategies in this regard are: 1) using MT+PE to reduce similarity to the source text and improve their own summarised or paraphrased texts; 2) employing MT+PE to support comprehension and paraphrasing difficult academic texts. Students' fifth purposeful use of MT is to cross-check and evaluate MT output, which they consider necessary before deciding whether to accept MT output or to edit. Their strategies are: 1) using more than one MT tool, potentially in consultation with additional HLT tools (e.g., dictionaries and search engines), to cross-check and cross-reference MT output; and 2) pre-editing of MT input to make it transparent in meaning and simple in form to receive more accurate MT output. The findings show that when students use two or more MT tools and additional HLT resources as complementary strategies, they become better able to judge MT accuracy, post-edit inappropriate MT output, and increase translation accuracy (see also Chang, 2022).

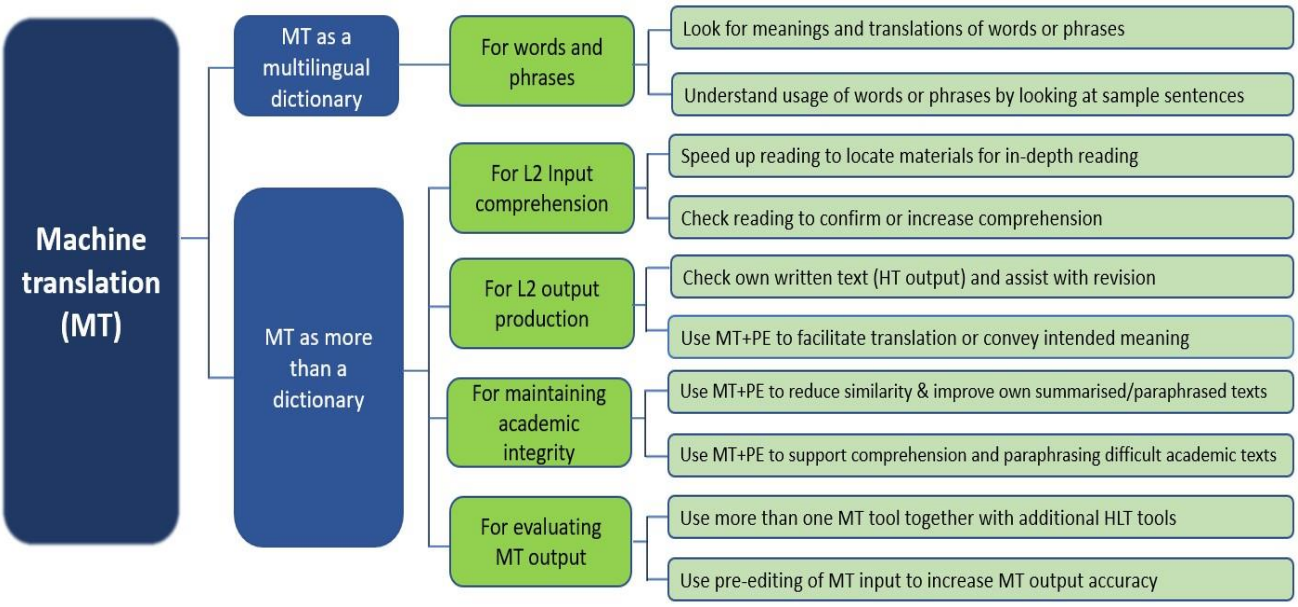


Figure 8.1 Multilingual learners' five purposeful uses of MT

The recognition and understanding of students' purposeful uses of MT contributes to and expands previous literature on SLA (including CALL as discussed in this study), translation and translanguaging in language learning and teaching and EMI contexts. The findings reveal how interactions between humans (students) and machines (MT and additional HLT tools) can facilitate the process of learning languages and gaining access to information and knowledge. This study demonstrates how human-machine interaction, the 'mutual or reciprocal action or influence' between human intelligence and machine intelligence, can maximise learning,

especially learner-centred learning (Salaberry, 1996, p. 25). In this study, students draw on their multilingual capability, cognitive skills (e.g., analysing, comparing, and interpreting), and technology skills in MT and PE to gain understanding and express their intended meaning. This supports the argument that students tend to utilise technology resources to make their learning more efficient and effective (Dingli & Seychell, 2015; Ducar & Schocket, 2018). MT and PE provide opportunities for multilingual learners to make use of their broader range of linguistic repertoires, semiotic resources and existing knowledge to support meaning making and gaining understanding. In other words, multilingual learning is extended and amplified by purposeful uses of MT and by the process of PE, through which multilingual learners can more effectively draw on existing language(s) and knowledge to strengthen their developing language and knowledge, and to transfer existing knowledge between languages (Cook, 2018; Slembrouck et al., 2018). In brief, understanding how multilingual learners use MT offers insights into how they exploit MT and PE strategically to support input comprehension and output production.

8.1.2 MT and PE to advance learning of language and knowledge

The purposes for which students use MT and PE are related to RQ2 (Can MT and PE capabilities advance L2 learning of multilingual learners? If so, how?). Five interrelated processes through which students not only advance L2 learning but also gain access to content knowledge have been identified in the study. MT and PE capabilities are understood here as the expertise to use MT as a resource and MT+PE as a strategy combination to facilitate learning, as indicated in Figure 8.1. Two important steps in the process of MT+PE are MT evaluation by analysing and comparing the source text/language and the MT text/language for equivalent transfer of meaning, followed by editing and/or modifying unsuitable MT output for appropriate translation. These two steps often require consultation with additional HLT tools. MT and PE, therefore, require students' capabilities in at least two languages and also in HLT tool use. Analysis of the findings suggests that MT and PE capabilities entail multilingual capability; skills in consulting tools, solving problems, making decisions; ability to use MT as a resource and MT+PE as a strategy combination; and MT evaluation and modification (see Figure 8.2).

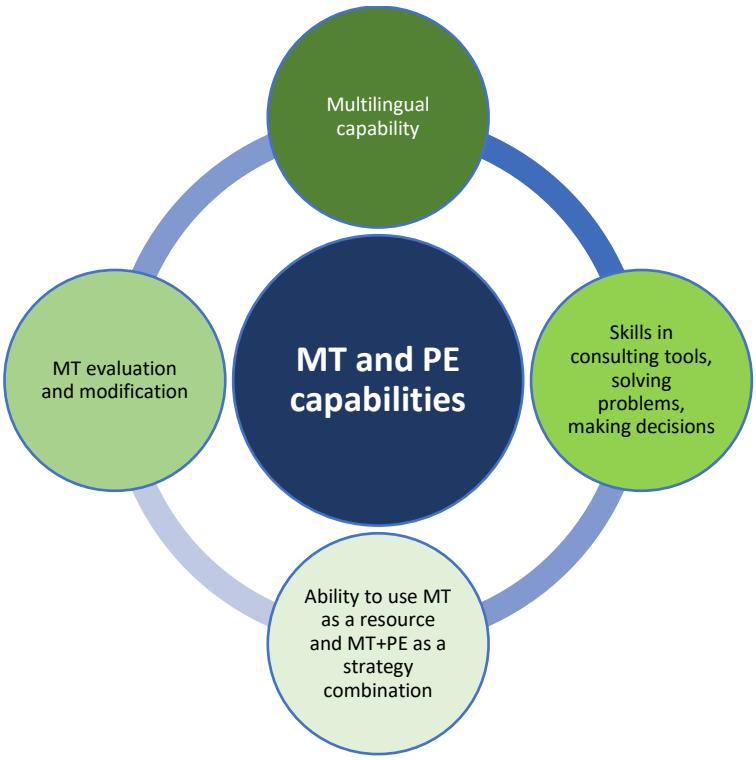


Figure 8.2 MT and PE capabilities

In this study learning to use MT and PE to develop and strengthen capabilities in MT and PE advances students' language learning and access to knowledge of learning content through five interrelated processes. These are: increasing efficiency in reading, improving accuracy in text comprehension and production, increasing opportunities for learning and understanding vocabulary and grammar, increasing confidence in learning, and raising awareness of appropriate use of MT (see Figure 8.3). Increasing efficiency in reading allows students to save time and increase text comprehension. This study indicates that reading L2 texts, particularly more difficult academic texts, side by side with L1 MT output speeds up reading, including when searching for appropriate learning materials (e.g., academic papers) from multiple online resources, and enables more careful reading once materials are located. This resonates with Krashen's (1985) notion of making input more comprehensible, thus increasing reading efficiency and triggering in-depth reading. Through in-depth reading, comprehension is enhanced, thereby leading to increasing text production accuracy.

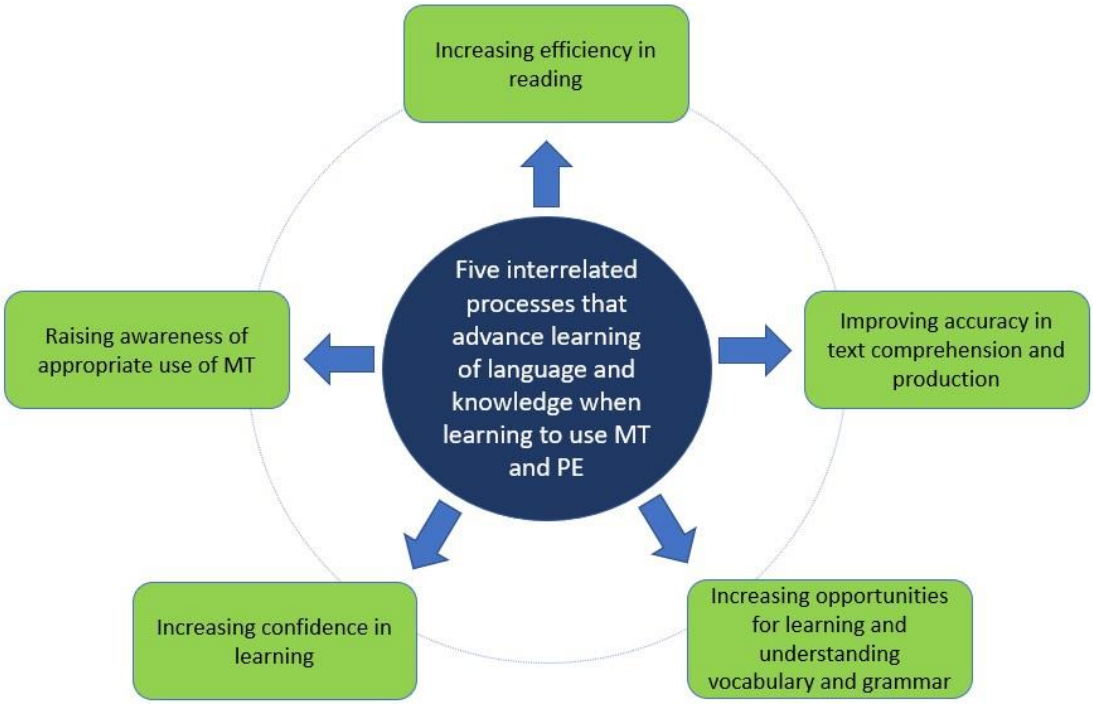


Figure 8.3 Five interrelated processes that advance learning of language and knowledge when learning to use MT and PE

The students also use MT output as feedback to check what they read and write followed by making revisions, and they use MT+PE to assist with translation and with conveying intended meaning in written output. In using MT and PE, the students negotiate meaning and both lexical and syntactic form between the source text (including their own text or HT output) and the MT text. MT and PE push students to pay attention to similarities and differences in the use of language between texts and to produce modified output. This suggests that language learning may take place through paying attention to meaning and form in language (Long, 2017) and to generate 'comprehensible output' or make modifications to output production (Swain, 2005). MT and PE encourage cognitive processes including attention and noticing, which are essential components of language acquisition. As Schmidt (2012) puts it: 'Paying attention results in more noticing…achieving higher levels of awareness and enhanced learning as a result' (pp. 40-41).

Learning to use MT and PE to increase accuracy in text comprehension and production simultaneously increases opportunities for learning and understanding vocabulary and grammar. Students in this study demonstrate increased understanding of vocabulary and grammar through comparisons between the source and MT texts and languages. This contributes to additional L2 learning. When students increase efficiency in reading and improve accuracy in text comprehension and production, they concurrently increase confidence in

learning. The students demonstrate increasing confidence with knowledge of how to use MT and PE to support L2 reading and writing. More importantly, with growing confidence in the use of MT and PE, students demonstrate increasing awareness of their appropriate, critical and judicious use of MT.

Previous research proposes that skills in MT and PE are important for translation students (e.g., Cadwell et al., 2018; Moorkens, 2018) and multilingual researchers (e.g., Bowker & Ciro, 2019; O'Brien et al., 2018); however, the nature of MT and PE skills are not explored. The present study sheds light on the nature of MT and PE capabilities through analysing multilingual learners' purposeful use of MT and PE processes, as shown in Figure 8.2. In addition, the study offers insights into five interrelated processes that occur when learning to use MT and PE, through which students advance their language learning and access to knowledge (see Figure 8.3). The findings explain why these students consider that the use of MT and PE comply with academic integrity protocols while supporting academic reading and writing. This research suggests that MT and PE capabilities are equally important for multilingual learners in both language learning and teaching and EMI contexts.

The study points to how and why explicit teaching of the use of MT and PE for both language and EMI students has value. Learning to use MT and PE appears to develop MT and PE capabilities and facilitate learning of language and knowledge. In short, students' five purposeful uses of MT (Figure 8.1) and five interrelated processes involved in MT and PE (Figure 8.3) offer cogent pedagogical insights for both sets of stakeholders. The study may also contribute to understanding and recognition of the high level (meta)cognitive and (meta)linguistic capabilities required in MT and PE in academic learning processes.

8.1.3 MT and PE towards multilingualism

MT and PE function as scaffolding for learning, enabling students to draw on their prior languages (e.g., L1) and prior knowledge to leverage learning of additional languages and new knowledge. With the use of MT and PE, the students in this study appear to be better able to use their broader range of linguistic and semiotic resources to make meaning and gain understanding. This suggests that interactions between students and machines may facilitate 'functional multilingual learning' in which learners' whole multilingual repertoire is viewed as a resource for language and knowledge learning (Sierens & Van Avermaet, 2014). MT permits students to draw on their stronger language to bridge gaps in the weaker language, while MT+PE allows students to use their existing language and knowledge systems together with

other HLT tools to increase the degree of accuracy in translation. Taken together, MT and PE can be shown to enhance language learning and knowledge acquisition through human-machine interaction, thus promoting multilingual capability and multilingualism.

Furthermore, MT and PE appear to facilitate vertical translanguaging, i.e., formal use of translation to achieve precision in high-status registers and texts for high-stakes purposes, and also transknowledging, i.e., bidirectional exchange and translation of knowledge (Heugh, 2021; Heugh et al., 2022). In this study, students strategically use MT and PE to support L2 reading and writing to understand learning materials more fully and to generate more accurate or appropriate written assignments. Thus, MT and PE facilitate students' translation processes when considered in terms of Nida's (1969) three-phase model comprising source text analysis to achieve a fuller understanding, then transfer of meaning corresponding to the expectations of the target language and culture, concluding with a restructuring of translated texts to produce an appropriate final translation. In this sense, MT and PE assist students to learn a language while gaining access to content knowledge through translanguaging and transknowledging. This study, therefore, suggests that it is necessary to integrate MT and PE into language pedagogy and curricula to equip multilingual learners with MT and PE capabilities both in the context of language learning and teaching and in the context of EMI. In so doing, language teachers and educators in HEIs can provide multilingual learners with equal opportunities for accessing knowledge and information in a language different from their L1. This, too, demonstrates recognition of language diversity and makes education more inclusive and socially just.

8.2 Concluding reflections

The first part of this study with the advanced students of Chinese in SG1 enabled me, as a teacher researcher, to understand how these Chinese language students used MT and PE strategically to facilitate translation processes and to resolve their language challenges experienced in learning Chinese. Recommending the four MT tools (Google Translate, Microsoft Translator, Baidu and Youdao) and requiring students to perform MT+PE using the tools in class led to an important finding. That is, using more than one MT tool to cross-check MT output could make MT evaluation more effective. The observation gained from SG1 and my personal experience with MT and PE enabled me to guide the EMI postgraduate students in SG2 on how to make use of MT and PE to assist with academic reading and writing. What impressed me even more was the postgraduate students' applications of MT and PE to assist the complex processes of paraphrasing and/or summarising. Towards the end of data analysis,

I realised that using MT+PE to facilitate translation requires one set of metacognitive and metalinguistic processes to carry out translation from a source text/language to a target text/language. However, employing MT+PE to facilitate paraphrasing in L2 requires two sets of metacognitive and metalinguistic processes of translation from L2 to L1 and back translation from L1 to L2. The first round of translation is to gain a better understanding of the source text in L2, and the second round is to generate a linguistically and culturally appropriate paraphrased text in L2. These make paraphrasing in L2 more complex and challenging than unidirectional translation from one language to another.

Prior to this study, as a language teacher, I was dubious about the use of MT for language learning because I had a very little understanding of MT and did not believe it could be used as a tool. Owing to the 'target language only' policy and conventions at the International Chinese Language Program (ICLP) where I worked, it was expected that one should use only the target language (Chinese) to teach students of Chinese and students were not permitted to use their primary language such as English at the institution, except in the English-Chinese translation course. As a multilingual speaker with Chinese as L1 and also a postgraduate student studying through EMI, I have entirely changed my opinions on using L1 for language learning and my negative views of the use of MT by students. I now recognise the value of encouraging multilingual learners to use their whole linguistic repertoire and range of resources, including using MT as a resource and MT+PE as a strategy combination, to engage in translanguaging and transknowledging practices (Heugh et al., 2022) for learning of language and accessing content knowledge.

I have genuinely appreciated the opportunity to undertake this study with my student participants. It was a reciprocal learning process in which we (teacher-students and students-students) were learning from one another from different positions – I as a language teacher and researcher, and they as students and each other's peer teachers. This learning process enhanced our reciprocal multilingual awareness (cf. Windle et al., 2023). My role was to facilitate and mediate the intervention process, and this student-centred approach importantly allowed me to learn and observe students' interaction with MT. Through the ongoing process of reflection, reflexivity and praxis, I have recognised that MT can be a helpful AI tool if used appropriately. This can inform my own future teaching design and practice.

Lastly, upon reflection, it seems likely that the MT and PE expertise, including critical and ethical skills, which students develop and learn, may be portable to other AI resources and

technologies. Capabilities in MT and PE such as judgments of reliability and accuracy, cross-checking of content, post-editing of content to suit purposes, and consulting HLT tools to assist problem solving and decision-making can apply to the use of different AI technologies (e.g., ChatGPT). An important implication of this study is that both students and academic staff in HEIs (will) need expertise in and understanding of the value in MT and PE. This points to the importance of developing policy and professional learning for staff about MT and PE, based on research into actual practice. The findings of this study may also contribute to informed HEI policy decisions on academic integrity in relation to MT. As Groves and Mundt (2021) argue, if students are required to acknowledge their MT use, then HEI policies should clearly provide examples of how to use and reference the use of MT tools.

8.3 Limitations

There were three limitations in this study. First, the research was based on two small samples of participants. The reasons for this have been explained in a COVID statement on page xii and in the Chapter 4 methodology. However, despite the limitation, the small number of students enabled me to work closely with them in an online environment to collect and analyse detailed screen recording data. Second, the research participants were limited to students at CEFR B2/C1 levels; this study did not take into account students below CEFR B2 levels. Research with students below B2 levels might render different results. Third, while students' perceptions of using MT in relation to concerns of academic integrity were collected, opinions of teaching staff were not part of this research. This suggests a future opportunity to build on the present study to examine the understanding and opinions of academic staff on students' use of MT in relation to academic integrity. Despite the limitations, this study has provided sufficiently valuable insights into the potential of MT and PE in language learning and teaching and EMI higher education contexts to warrant further large-scale research.

8.4 Recommendations

Through several iterations of reflection, reflexivity and praxis in the teaching interventions, and analyses of the findings, I now offer three recommendations for future teaching practice. The first one focuses on using HT, MT and PE as complementary strategies when applying translation to language education. The second sets out suggestions for MT and PE teaching design. The third focuses on the teaching of paraphrasing and summarising with MT and PE. I also provide some suggestions for future research.

8.4.1 HT, MT and PE as complementary strategies

Translation can be a pedagogical tool or approach for language teaching (e.g., Cook, 2010, 2018). This study, however, shows that when students translate from scratch or undertake HT, they also consult HLT tools, including MT, dictionaries and search engines, in order to understand the source text and generate an appropriate target text. This study also reveals that using HT, MT and PE as complementary strategies for translation is more beneficial for language learning. Figure 8.4 displays a recursive HT-MT-PE sequence of translation processes with a one-directional arrow, starting with HT and then switching to MT and PE when needed. As indicated in the literature, the term PE is often used together with MT; therefore, editing of HT output is not treated as PE in this research. This study shows that focusing on HT-MT-PE translation processes can encourage students to treat MT and PE as resources and strategies to support HT and avoid students' over-reliance on MT. This means raising awareness of critical, judicious and ethical use of MT. Hence, I recommend that paying attention to the complementarity of HT, MT and PE, i.e., following a recursive HT-MT-PE translation process, may be an effective translation pedagogy for language education.

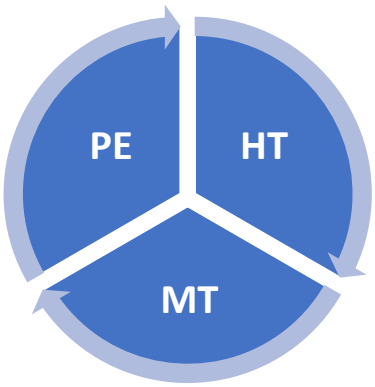


Figure 8.4 Recursive HT-MT-PE translation processes

8.4.2 MT and PE teaching design

This study has highlighted the benefits of learning to use MT and PE for multilingual learners in language learning and teaching and EMI contexts. Based on my analysis of the teaching interventions and the research findings, I recommend a pedagogical design that comprises a four-phase process involving HT and MT-related activities (Figure 8.5).

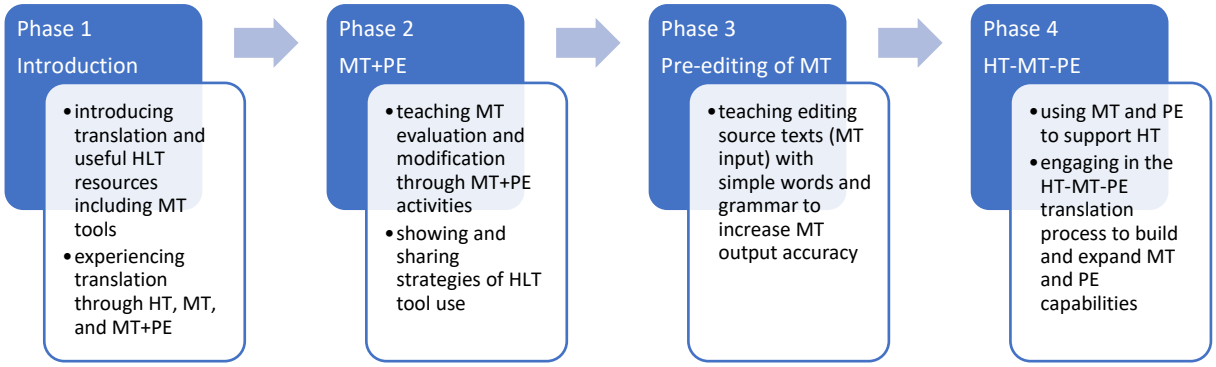


Figure 8.5 A four-phase teaching design for MT and PE

The first phase plays an important role in providing basic knowledge of translation (e.g., definitions of translation, standards of translation, and classifications of translation) and introducing useful HLT resources including MT tools. The teacher can have students translate through HT, MT, and MT+PE to experience different translation methods. The comparison of the advantages and disadvantages of each method in terms of translation processes and products can be included in the classroom discussion.

The teaching focus of the second phase is MT output evaluation and modification by means of MT+PE activities. Students can choose one MT tool to generate translations for a selected text, followed by PE. The selection of translation texts can be made jointly by both teachers and students. Both literary (e.g., stories and prose) and non-literary (e.g., news articles and academic papers) types of texts should be included so students can compare the quality of MT output for varying text genres. More importantly, students should be advised of the strategies related to: 1) using HLT tools to assist judgements of MT accuracy and 2) post-editing of MT output to suit intended purposes. This study shows that such strategies include using more than one MT tool to cross-check and cross-reference MT output, employing dictionaries to check word meaning and usage, and adopting search engines to look for word translations, definitions, and collocations (Chang, 2022).

In the third phase, the teaching practice focuses on pre-editing of MT input activities to provide students with the experience of using controlled language (CL), i.e., simple and unambiguous lexis and syntax (Shih, 2020a, 2020b). This is for students to edit source texts (MT input) using CL to make them clear in meaning and simple in form in order to generate improved target texts (MT output). This study indicates that the strategy of pre-editing of MT input to make the source text transparent allows students to receive more accurate MT output. Basically, the

activities in the second and third phases are designed to help students manipulate MT tools through critically examining MT input and output.

In the fourth phase, the teaching focus is using MT and PE to support HT, i.e., engaging in the HT-MT-PE translation process. As shown in Figure 8.4, students start translating texts with HT, and then use MT and PE to assist HT if needed. The activities in this phase can include translation from L2 to L1 (reading in L2) through the HT-MT-PE process and translation from L1 to L2 (writing in L2) through the same process. Figure 8.1, multilingual learners' five purposeful uses of MT to support input comprehension and output production can be used as a model to support HT. It is expected that multilingual learners, including language students and EMI students, may develop and expand MT and PE capabilities through explicit pedagogical guidance. Simultaneously, they may advance their learning of language and content knowledge through learning to use MT and PE.

8.4.3 MT+PE to support paraphrasing and summarising

According to this study, guiding students on how to apply MT+PE to support paraphrasing and summarising academic texts appears important. To avoid potential academic misconduct, it is necessary to advise students to paraphrase or summarise in their own L1 words prior to using MT to translate into the L2 followed by PE. Figure 8.6 shows a four-phase process of teaching paraphrasing and summarising with MT+PE.

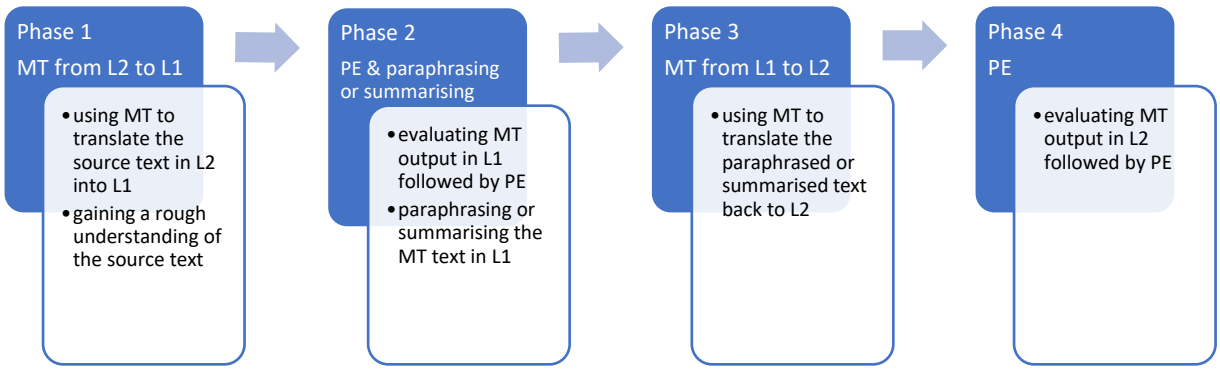


Figure 8.6 A four-phase process of teaching paraphrasing and summarising with MT+PE

When students encounter difficult academic texts, they can use MT to translate the source text in L2 into L1, which is to give them a rough understanding of the source text (Phase1). They then need to evaluate MT output in L1 followed by PE, and paraphrase or summarise the MT text in L1 (Phase 2). It is more effective to undertake PE before paraphrasing or summarising the L1 MT text, especially when the MT output is not entirely accurate. Phase 2 is for students

to rewrite the text in their own words and to demonstrate their understanding of the source text, which is considered important for content knowledge acquisition. Also, rephrasing in their own words prior to translating into the L2 can reduce similarity to the source text, and therefore can avoid potential academic misconduct. Subsequently, they can use MT to translate the paraphrased or summarised text in L1 back to L2 (Phase 3). Lastly, they need to evaluate the MT output in L2 followed by PE to ensure a greater degree of accuracy and appropriateness in translation (Phase 4). This four-phase process of paraphrasing or summarising with MT+PE provides students with an alternative when they confront difficulties in understanding and paraphrasing or summarising challenging academic texts.

In summary, students starting with HT and then changing to MT and PE when having trouble in the transfer of meaning, i.e., using MT and PE to assist HT, appears to be beneficial for language learning, as indicated by this study. Hence, focusing on the complementarity of HT, MT and PE and on recursive HT-MT-PE processes (Figure 8.4) can be especially effective when applying translation as a pedagogical approach. The effective use of MT and PE, however, requires explicit teaching guidance. Hence, a four-phase teaching design for MT and PE is proposed (Figure 8.5), the goal being that students can understand how to use MT and PE as resources and strategies to support their learning of language and content knowledge. As shown in this study, students also use MT for paraphrasing and/or summarising in academic writing, and therefore a four-phase process of teaching paraphrasing and summarising with MT+PE is suggested (Figure 8.6). The four-phase process emphasises evaluating and post-editing of MT content and paraphrasing or summarising in students' own words to demonstrate understanding and avoid potential academic misconduct. Together, the core purpose of the three recommendations is to teach multilingual learners in both language learning and EMI contexts how to use MT critically and ethically while advancing their language learning and access to knowledge of learning content. The recommendations are expected to be beneficial and applicable to any multilingual learners in diverse contexts, such as studying a higher degree through Chinese medium instruction (CMI).

8.4.4 Future research

This research serves as a preliminary study on the potential of MT and PE to advance L2 learning in the contexts of language learning and teaching and EMI. Moreover, since MT and PE require students' linguistic capability in at least two languages, students' multilingual capability is one of the factors influencing how they use MT and PE. Further large-scale and potentially longitudinal studies could be carried out to validate and further the findings of this

study. It may be worthwhile to consider the following research directions that focus on students:

1) A study on students' use of MT and PE to explore how this may lead to improved reading and writing in L2, and whether students' writing quality (without the use of MT) improves after writing with MT over an extended period of time.

2) An investigation of whether MT can advance L2 listening and speaking, and if so, how? Understanding the role of MT to support listening and speaking seems highly valuable for language education.

3) An investigation of the metacognitive and metalinguistic load of translation, together with paraphrasing and summarising in an L2 alongside MT and PE.

4) The affordances of different MT tools for different purposes and directionality in translation. This may contribute to an understanding of which MT tool to select depending on the purposes and directionality of translation. For example, whether affordances for CMI students are similar to or different from those for EMI students.

The subjects of this study were students at CEFR B2/C1 (upper-intermediate/advanced learners of the L2) levels. It might be worth exploring how students at A1/A2/B1 (beginner/pre-intermediate/ intermediate) levels use MT and whether MT and PE can enhance their language learning. This might contribute to an understanding of how students below B2 levels interact with MT in learning and implications for teaching and incorporating MT into the classroom. Previous research shows that using MT can be challenging for these students (Lee, 2022a, 2022c). Considering that many multilingual learners, regardless of levels, have been using MT technology for their study, it would be valuable to understand whether students at different language levels use MT in different ways, and whether MT and PE can support students at A1/A2/B1 levels.

There is also reason to turn attention towards academic teaching staff and HEI policy. Future research could explore the understanding of MT by academic teaching staff with various linguistic backgrounds and disciplines and their perceptions of students' use of MT in relation to concerns of academic integrity. Some previous studies have explored the perceptions of academic staff (Groves & Mundt, 2021; Jolley & Maimone, 2022; Lee, 2023). However, teaching staff with distinct linguistic and cultural backgrounds and different experiences with MT may have dissimilar views of students' use of MT. A study of staff (and HEI)

understanding of MT may enhance institutional and teaching staff approaches to MT use, including in regard to metacognitive and metalinguistic agency, academic integrity, and the value of MT and PE in higher education more broadly. Such a study may contribute to future decision-making and HEI language policy (including MT use).

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Appendices

Appendix 4.1 Participant information and consent forms (SG1)

Participant Information Sheet (SG1)

This project has been approved by the University of South Australia's Human Research Ethics Committee (ID '202622'). If you have any ethical concerns about the project or questions about your rights as a participant, please contact the Executive Officer of this Committee, Tel: +61 8 8302 3118; Email: vicki.allen@unisa.edu.au

Project Title: Investigation of post-editing machine translation (PEMT) in advancing reading and writing capability of English and Chinese language learners in higher education

Researcher: Li-Ching Chang li-ching.chang@mymail.unisa.edu.au

Principal supervisor: Associate Professor Kathleen Heugh Kathleen.heugh@unisa.edu.au

Co-supervisors: Dr Enza Tudini Enza.tudini@unisa.edu.au;

Professor Ning Gu Ning.gu@unisa.edu.au

Research outline

Translation is regarded as a natural and inevitable strategy for second language acquisition, and it is also considered to be an effective and efficient process in language teaching and learning. Post-editing machine translation (PEMT) in this research denotes a translation strategy in which translation made from machine translation software, e.g., Google Translate and Microsoft Translator, is followed by human post-editing. PEMT has recently come to be viewed as an important skill in translation studies and language service industries because competent post-editing can supplement the deficiency of machine translation. The primary aim of this research is to explore the potential of PEMT in advancing learners' reading and writing skills in the second language. This study will be conducted in a translation workshop which will be held at International Chinese Language Program (ICLP) in Taiwan in April and May 2020, and this workshop will be instructed by the researcher who established and taught translation courses at ICLP before leaving for the PhD at the University of South Australia (UniSA). In general, this workshop is an eight-week program and will be run on the basis of two hours a day and two days a week in the afternoon (e.g., 3pm-5pm or 4pm-6pm) so that it will not clash with regular Chinese courses of students.

What does the research involve for participants?

If you agree to participate, you will be asked to complete a consent form. The research has four phases and details are as follows.

1. Pre/post questionnaire surveys: You will be asked to complete two questionnaires. The questionnaires are to collect information about your use of translation technology at the beginning and at the end of the workshop. Each survey would take around 10-15 minutes to complete.
2. Pre/post-intervention tasks: You will have to translate two 100-word texts respectively from English to Chinese and Chinese to English in 90 minutes in the ICLP computer classroom. Internet access to make use of any online resources is permitted, while screen recordings will be used to capture your translation processes for data collection (Please note that only translation processes on the computer screen will be recorded. This does not include your facial image).
3. Translation activities: You will undertake eight in-class translation activities via PEMT and/or HT (HT refers to human translation approach in which translation is produced by a human translator, potentially with consultation of dictionaries.) The length of source texts used for in-class translation activities is around 150 words, and the translation task completion time is up to 30 minutes followed by 50 minutes of target text discussions. The source text types selected will involve both literary and non-literary texts. However, the professional fields and interests of participants will be considered when selecting authentic translating materials. You will be instructed to produce translations through both approaches (HT and PEMT) in the first four weeks. Starting from the fifth week, you can use either HT, PEMT or both to undertake the rest of the in-class translation tasks. In general, the in-class translation activities are to activate your linguistic repertoires and strengthen your language capabilities. Through these activities, you will be able to compare your translation quality via HT and PEMT, discuss which approach benefits you when completing the translation tasks and what difficulties you encounter when translating via HT and PEMT. My observations of these activities will assist me in a) comparing your translation quality via HT and PEMT; b) understanding which approach is most beneficial for language learning; and c) understanding what difficulties you encounter when translating via HT and PEMT.
4. Interviews: You may be invited to volunteer to participate in a 30-minute focus group conversation or an individual interview which will be conducted in a quiet classroom. If you agree to participate in either a group conversation or an individual interview, you will be asked to sign an additional consent form. The interview will be audio-recorded and then transcribed by the researcher. The transcripts will be checked back with you to ensure the accuracy of the content. Your name will not be identified on the transcripts and your personal details will remain confidential. We will take every care of confidentiality, however, for those participating in a focus group conversation, given the public nature of focus groups, confidentiality and anonymity of focus group discussions and participation cannot be guaranteed.

Who can participate?

Students aged 18 and over, and who will be **at advanced level (level 6) and over in the Spring term/quarter 2020** at ICLP, are invited to participate in this study. Participation is voluntary and a student's decision to take part (or not to take part or to withdraw from the study) will not influence their position/enrolment with their home University and/or their assessment/grades.

You are free to decline to participate or to withdraw from the research project at any stage without affecting your relationship with the researchers or the Institutions supporting this research, now or in the future. Please note that, should you choose to withdraw from the study, you have until two weeks after the completion of your involvement in the project to request that your data be removed from the study.

There will be no expense incurred to participants of this study. A NT$500 gift card will be available for each of the participants who volunteer to participate in a focus group conversation or an individual interview.

How will the data be used and stored?

Access to collected data will be restricted to the research team listed above. All hard copy data will be transferred to electronic data and both hard copy and electronic data will be stored in a locked filing cabinet at UniSA's Magill Campus. A copy of all electronic data will also be stored on the secure UniSA server. All data will be securely kept for five years in line with university protocols. The names of participants will be re-identifiable/coded and the list of participants' real name will be kept separately from the collected data (and only accessible to research team members listed above). All records containing personal information will remain confidential and no information which could lead to identification of any individual will be released unless required by law. Individual student's information/responses will not be provided to their institutions and only non-identifiable data will be reported. The researcher will take every care to remove any identifying material from the responses you provide as early as possible and participants will not be identified in the reporting of the research. However, please be aware that the researcher cannot ultimately guarantee the confidentiality or anonymity of material transferred by email or the internet.

Participant benefits and risks

Participant benefits may include learning how to activate your language repertoires, further strengthen your language expertise through translation activities, and learning how to make appropriate use of translation technology. It is not anticipated that there are any risks to participation in this study beyond those encountered during everyday life.

Dissemination of the study results

The findings and results of the research project will be disseminated and available online at its completion for all participants.

How can your participation help?

Your participation will assist to gain insights into the potential of PEMT in advancing university students' reading and writing proficiency in the second or additional language. Moreover, it will help language learners, second/additional language speakers as well as educators to gain a better understanding of 1) how to make the best use of translation technology to facilitate language learning and language use; 2) how to make ethical use of translation technology; 3) how developing capability in PEMT assists learners to strengthen

language proficiency and maintain academic integrity in academic work; and 4) the affordances and limitations of translation technology.

Contact information for a complaint

Participants or third parties who wish to lodge a complaint about either the study or the way it is being conducted should contact the Executive Officer of UniSA HREC in the first instance, email: humanethics@unisa.edu.au or tel: 8302 3118.

If you are interested in participating in this study, please carefully read and complete the attached consent form and return it to Ms Wenlin Hsien at RM 420, ICLP Office. As there are limited places, registration will be on a first-come-first-served basis.

Participant Consent Form (SG1)

This project has been approved by the university of South Australia's Human Research Ethics Committee (ID '202622').

Project Title: Investigation of post-editing machine translation (PEMT) in advancing reading and writing capability of English and Chinese language learners in higher education

Researcher: Li-Ching Chang Email: li-ching.chang@mymail.unisa.edu.au

Principal Supervisor: A/Prof Kathleen Heugh Email: kathleen.heugh@unisa.edu.au

Co-supervisors: Dr Enza Tudini Email: enza.tudini@unisa.edu.au

Prof Ning Gu Email: ning.gu@unisa.edu.au

- I have received information about this postgraduate research project.
- I understand the purpose of the research project and my involvement in it.
- I acknowledge that my decision to take part (or not to take part or to withdraw from the study) will not influence my relationship with the researchers (and the institutions supporting this project) or my position/enrolment with my home University and my assessment/grades.
- I understand that I will be asked to complete the pre/post questionnaire surveys.
- I understand that I will be asked to complete the pre/post-intervention tasks and the translation processes will be screen recorded.
- I understand that I will be undertaking eight in-class translation activities.
- I understand that I may be invited to volunteer to participate in a focus group conversation or an individual interview which will be audio-recorded and then transcribed by the researcher.

- I will not be identified and my personal details will remain confidential. I understand that no information which could lead to my identification will be released, unless as required by law.
- I understand that access to the collected data will be limited to the researcher and the researcher's university supervisors.
- I understand that all data (including audio recordings of the interviews and focus groups) will be stored securely (on the University of South Australia computer servers and in local filing cabinets) at the School of Creative Industries.
- If I am involved in a focus group session, I agree to maintain the confidentiality of group discussions and preserve the anonymity of focus group participation.
- I understand the statement in the information sheet concerning payment to me for taking part in an interview / focus group.
- I understand that I can discuss any ethical concerns about the research with UniSA Human Research Ethics Committee at 61-8-8302-3118 or: humanethics@unisa.edu.au
- I understand that I can discuss any other issues in relation to this research with the supervisors of the researcher via email provided above.

Name of participant: _____

Signed: _____ Date: _____

…….....

Office use only

I have provided information about the research to the research participant and believe that he/she understands what is involved.

Researcher's signature: _____ Date: _____

Appendix 4.2 Questionnaires (SG1)

Pre-intervention questionnaire (SG1)

I. Background information

1. Gender (Please identify your preferred gender identity):

2. Age range: 18-24 □ 25-34 □ 35-44 □ 45-54 □ 55 + □

3. Your home language(s):

4. Your second or additional language(s):

5. Your Chinese level at ICLP? □ Level 6 □ Level 7

6. Academic backgrounds:

Undergraduate student □ Majoring in _____

Postgraduate student □ Research field _____

Other □ _____

II. Experience of using machine translation

1. Have you ever used free machine translation (MT) to support your Chinese reading and writing processes? (MT, such as Google Translate, translates texts electronically.)
Yes □ No □

If yes, which MT do you use? (Tick all that apply.)
Google Translate □ Microsoft Translator □ Baidu □ Youdao □ Other □ _____

2. How frequently do you use MT in Chinese learning for the following purposes? (Please circle a number.)

	Always	Almost always	Sometimes	Rarely	Never
2.1 Reading comprehension	5	4	3	2	1
2.2 Writing production	5	4	3	2	1
2.3 Translating words	5	4	3	2	1
2.4 Translating phrases	5	4	3	2	1
2.5 Translating sentences	5	4	3	2	1
2.6 Translating paragraphs	5	4	3	2	1
2.7 Translating a whole text	5	4	3	2	1
2.8 Checking what you read in Chinese	5	4	3	2	1
2.9 Checking what you wrote in Chinese	5	4	3	2	1
2.10 Any other purposes which are not listed above?					

Please answer the following items to tell me what you think about MT or post-editing of MT (PEMT).

	Strongly agree	Agree	Somewhat agree	Disagree	Strongly disagree
3. MT/PEMT can save time on course work.	5	4	3	2	1

4. MT/PEMT can produce more accurate course work.	5	4	3	2	1
5. MT/PEMT can increase confidence in reading.	5	4	3	2	1
6. MT/PEMT can increase confidence in writing.	5	4	3	2	1
7. MT/PEMT is helpful in Chinese learning.	5	4	3	2	1
8. MT/PEMT is helpful in preparing course work.	5	4	3	2	1
9. MT/PEMT can strengthen my Chinese reading.	5	4	3	2	1
10. MT/PEMT can strengthen my Chinese writing.	5	4	3	2	1
11. Chinese translations from MT are accurate.	5	4	3	2	1
12. English translations from MT are accurate.	5	4	3	2	1
13. I always do post-editing or proofreading when I use MT.	5	4	3	2	1
14. I know how to do post-editing of MT appropriately.	5	4	3	2	1
15. I have the ability to judge whether the Chinese translation from MT is accurate.	5	4	3	2	1

Post-intervention questionnaire (SG1)

I. Experience of using machine translation

1. Which MT do you use to support your Chinese reading and writing? (Tick all that apply.)
Google Translate □ Microsoft Translator □ Baidu □ Youdao □ Other □ _____

2. How frequently do you use MT in Chinese learning for the following purposes? (Please circle a number.)

	Always	Almost always	Sometimes	Rarely	Never
2.1 Reading comprehension	5	4	3	2	1
2.2 Writing production	5	4	3	2	1
2.3 Translating words	5	4	3	2	1
2.4 Translating phrases	5	4	3	2	1
2.5 Translating sentences	5	4	3	2	1
2.6 Translating paragraphs	5	4	3	2	1
2.7 Translating a whole text	5	4	3	2	1
2.8 Checking what you read in Chinese	5	4	3	2	1
2.9 Checking what you wrote in Chinese	5	4	3	2	1
2.10 Any other purposes which are not listed above?					

Please answer the following items to tell me what you think about MT or post-editing of MT (PEMT).

	Strongly agree	Agree	Somewhat agree	Disagree	Strongly disagree
3. MT/PEMT can save time on course	5	4	3	2	1

work.					
4. MT/PEMT can produce more accurate course work.	5	4	3	2	1
5. MT/PEMT can increase confidence in reading.	5	4	3	2	1
6. MT/PEMT can increase confidence in writing.	5	4	3	2	1
7. MT/PEMT is helpful in Chinese learning.	5	4	3	2	1
8. MT/PEMT is helpful in preparing course work.	5	4	3	2	1
9. MT/PEMT can strengthen my Chinese reading.	5	4	3	2	1
10. MT/PEMT can strengthen my Chinese writing.	5	4	3	2	1
11. Chinese translations from MT are accurate.	5	4	3	2	1
12. English translations from MT are accurate.	5	4	3	2	1
13. I always do post-editing or proofreading when I use MT.	5	4	3	2	1
14. I know how to do post-editing of MT appropriately.	5	4	3	2	1
15. I have the ability to judge whether the Chinese translation from MT is accurate.	5	4	3	2	1

II. Open-ended questions

1. Please write a few sentences or a paragraph to explain how you use PEMT.

2. In what ways do you think MT/PEMT is helpful in advancing your Chinese reading and writing capabilities?

3. To what extent do you think this translation course is helpful?

4. Other comments?

Appendix 4.3 Intervention tasks

Pre-intervention task

Please note: You have 90 minutes to translate FOUR texts from Chinese to English and English to Chinese. Internet access to make use of any online resources is permitted while translating. The process of your translation will be recorded for the purpose of research data collection; however, it does not include your facial image.

Source texts	Translations (Target texts)
1 人工智慧 科技發展之際，教育的方式得大幅改變才行。隨著 AI 崛起，教育變革成為必要之事。研究表示，目前的教育太過將人視作陶土，塑形燒製之後就無法改變外形，而非可以重塑的黏土。未來，愈來愈多工作得面臨自動化的挑戰，而最有價值的技能亦將不斷改變。 Source from The Economist: https://www.cw.com.tw/article/article.action?id=5082553	
2 同舟共濟 很久以前，有兩個國家的人民將對方視為仇敵。有一次，兩國的人剛好同坐一艘船渡河。在船上，正當他們差一點發生衝突時， 突然遇到暴風雨。眼見船就要翻了，為了保住性命，他們顧不得彼此的仇恨，反而互相救助，合力使船身穩定，最後終於安全到達岸邊 Source from: http://www.youjiao.com/e/20180609/5b1bd45a5816d.shtml	
3 Lance Armstrong (AMERICAN CYCLIST) Lance Armstrong**,** (born September 18, 1971, Plano, Texas, U.S.), American cyclist, who was the only rider to win seven Tour de France titles (1999–2005) but who was later stripped of all his titles after an investigation revealed that he was the key figure in a wide-ranging doping conspiracy while he compiled his Tour victories. Armstrong entered sports at a young age, excelling in both swimming and cycling, and by the time he was a teenager he was competing in triathlons and swimming competitions. Before his high-school graduation the junior national team of the U.S. Cycling Federation had recruited him. Source from Encyclopaedia https://www.britannica.com/biography/Lance-Armstrong	
4 An unwritten novel Life's what you see in people's eyes; life's what they learn, and, having learnt it, never, though they seek to hide it, cease to be aware of – what? That life's like that, it seems. Five faces opposite – five mature faces – and the knowledge in each face. Strange, though, how people want to conceal it! Marks of reticence are on all those faces: lips shut, eyes shaded, each one of the five doing something to hide or stultify his knowledge. One smokes; another reads; a third checks entries in a pocket book; a fourth stares at the map of the line framed opposite; and the fifth – the terrible thing about the fifth is that she does nothing at all. Source from Virginia Woolf's an unwritten novel	

Post-intervention task

Please note: You have 90 minutes to translate FOUR texts from Chinese to English and English to Chinese. Internet access to make use of any online resources is permitted while translating. The process of your translation will be recorded for the purpose of research data collection; however, it does not include your facial image.

Source texts	Translations (Target texts)
1 人工智慧 因應科技發展，教育方式亦隨之改變，一如工業革命造成的影響，工業取代農業。這催生了工廠模式的普及與國家教育，亦即由學校為工廠提供具備合適資格的勞工。AI 崛起亦有可能帶來同樣的效應，讓教育變革成為必要之事，並以適性教育來促成教育變革。 Source from The Economist: https://www.cw.com.tw/article/article.action?id=5082553	
2 同舟共濟 一次, 有人問孫武: “戰場上的士兵是否會相互照應? ″他回說: ″必然的。 比如兩個仇人, 同乘上一條船渡海, 遇到了狂風惡浪, 眼看就有葬身海底的危險時, 他們就會忘記舊仇, 同心協力與風浪搏鬥以避免翻船。連仇人在危險之時尚能同舟共濟, 何況沒有冤仇的將士呢? ″ Source from: https://baike.baidu.com/item/%E5%90%8C%E8%88%9F%E5%85%B1%E6%B5%8E/13767	
3 Lance Armstrong (AMERICAN CYCLIST) In June 2012 the U.S. Anti-Doping Agency (USADA) alleged that Armstrong and five of his associates had been part of a decadelong doping conspiracy beginning in the late 1990s. According to USADA, Armstrong used performance-enhancing drugs. The allegations resulted in his immediate ban from triathlon competition. In August of that year he declined to enter USADA's arbitration process, which led the agency to announce that it would strip him of all his prizes and awards from August 1998 forward—including his seven Tour de France titles—and enact a lifetime ban from cycling and any other sport that follows the World Anti-Doping Code. Source from Encyclopaedia https://www.britannica.com/biography/Lance-Armstrong	
4 An unwritten novel The best thing to do against life was to fold the paper so that it made a perfect square, crisp, thick, impervious even to life. This done, I glanced up quickly, armed with a shield of my own. She pierced through my shield; she gazed into my eyes as if searching any sediment of courage at the depths of them and damping it to clay. Her twitch alone denied all hope, discounted all illusion. So we rattled through Surrey and across the border into Sussex. But with my eyes upon life I did not see that the other travellers had left, one by one, till, save for the man who read, we were alone together. Source from Virginia Woolf's an unwritten novel	

Appendix 4.4 Interview questions

Focus group interview questions (SG1):

1. How would you use MT/PEMT for Chinese reading and writing now?
2. When would you use HT, MT and PEMT?
3. How do you ensure MT is accurate?
4. How do you use MT/PEMT and maintain academic integrity?
5. Would teaching in the use of MT/PEMT help to avoid plagiarism?
6. Have your views of using MT/PEMT changed during the course?
7. Has this course been useful? How?
8. Do you have suggestions to make this course more useful?

Focus Group Interview questions (SG2):

1. How would you use MT/PEMT for English reading and writing now?
2. When would you use HT, MT and PEMT?
3. How do you ensure MT is accurate?
4. How do you use MT/PEMT and maintain academic integrity?
5. Would teaching in the use of MT/PEMT help to avoid plagiarism?
6. Have your views of using MT/PEMT changed during the tutoring process?
7. Has this tutoring group been useful? How?
8. Do you have suggestions to make this tutoring more useful?

Appendix 4.5 Participant information and consent forms (SG2)

Participant Information Sheet (SG2)

This project has been approved by the University of South Australia's Human Research Ethics Committee (ID '202622'). If you have any ethical concerns about the project or questions about your rights as a participant, please contact the Executive Officer of this Committee, Tel: +61 8 8302 3118; Email: vicki.allen@unisa.edu.au

Project Title: Investigation of post-editing machine translation (PEMT) in advancing reading and writing capability of English and Chinese language learners in higher education

Researcher: Li-Ching Chang li-ching.chang@mymail.unisa.edu.au

Principal supervisor: Associate Professor Kathleen Heugh Kathleen.heugh@unisa.edu.au

Co-supervisors: Dr Enza Tudini Enza.tudini@unisa.edu.au;

Professor Ning Gu Ning.gu@unisa.edu.au

Research outline

Translation is regarded as a natural and inevitable strategy for second language acquisition, and it is also considered to be an effective and efficient process in language teaching and learning. Post-editing machine translation (PEMT) in this research denotes a translation strategy in which translation made from machine translation software, e.g. Google Translate, Youdao and Baidu, is followed by human post-editing. PEMT has recently come to be viewed as an important skill in translation studies and language service industries because competent post-editing can supplement the deficiency of machine translation. The primary aim of this research is to explore the potential of PEMT in advancing learners' reading and writing skills in the second language. This research will be undertaken in a PEMT tutoring group guided by the researcher in the library study room at the university of South Australia (UniSA) from February to December 2020. This study will focus on how to appropriately use PEMT for academic reading and writing.

What does the research involve for participants?

If you agree to participate, you will be asked to complete a consent form. This research has three phases and details are as follows.

1. Pre/post questionnaire surveys: You will be asked to fill out two questionnaires. The questionnaires are to collect information about your use of translation technology at the beginning and at the end of the PEMT tutoring process. Each questionnaire would take around 10-15 minutes to complete.
2. Tutorial discussion: You will be involved in five monthly-based meetings to discuss the use of PEMT in your research reading and writing. The discussion may include the

translation problems you encounter and the solutions identified while doing PEMT. Each discussion time will last approximately one hour. You are encouraged to bring your translations/working texts to tutorial discussions.

3. Interviews: You will be invited to participate in a one-to-one interview of maximum 30-minute duration in a quiet library study room. If you agree to participate in an individual interview, you will be asked to sign an additional consent form. The interview will be audio-recorded and then transcribed by the researcher. Transcripts will be checked back with you to ensure the accuracy of the content. Your name will not be identified on the transcripts nor be used in any reporting of the data and your personal details will remain confidential.

Who can participate?

Students over the age of 18, and who are **home language speakers of Chinese** studying postgraduate degree at UniSA, are invited to participate in this study. Participation is voluntary and a student's decision to take part (or not to take part or to withdraw from the study) will not influence their position/enrolment with their home University and/or their assessment/grades. You are free to decline to participate or to withdraw from the research project at any stage without affecting your relationship with the researchers or the Institutions supporting this research, now or in the future. Please note that, should you choose to withdraw from the study, you have until two weeks after the completion of your involvement in the project to request that your data be removed from the study.

There will be no expense incurred to participants of this study. A $ 30 gift card will be available for each of the participants who volunteer to participate in an individual interview.

How will the data be used and stored?

Access to collected data will be restricted to the research team listed above. All hard copy data will be transferred to electronic data and both hard copy and electronic data will be stored in a locked filing cabinet at UniSA's Magill Campus. A copy of all electronic data will also be stored on the secure UniSA server. All data will be securely kept for five years in line with university protocols. The names of participants will be re-identifiable/coded and the list of participants' real name will be kept separately from the collected data (and only accessible to research team members listed above). All records containing personal information will remain confidential and no information which could lead to identification of any individual will be released unless required by law. Individual student's information/responses will not be provided to their Institutions and only non-identifiable data will be reported. The researcher will take every care to remove any identifying material from the responses you provide as early as possible and participants will not be identified in the reporting of the research. However, please be aware that the researcher cannot ultimately guarantee the confidentiality or anonymity of material transferred by email or the internet.

Participant benefits and risks

Participant benefits may include learning how to make appropriate use of translation technology in academic reading and writing, and finding solutions to translation difficulties

and problems. It is not anticipated that there are any risks to participation in this study beyond those encountered during everyday life.

Dissemination of the study results

The findings and results of the research project will be disseminated and available online at its completion for all participants.

How can your participation help?

Your participation will assist to gain insights into the potential of PEMT in advancing university students' reading and writing proficiency in the second or additional language. Moreover, it will help language learners, second/additional language speakers as well as educators to gain a better understanding of 1) how to make the best use of translation technology to facilitate language learning and language use; 2) how to make ethical use of translation technology; 3) how developing capability in PEMT assists learners to strengthen language proficiency and maintain academic integrity in academic work; and 4) the affordances and limitations of translation technology.

Contact information for a complaint

Participants or third parties who wish to lodge a complaint about either the study or the way it is being conducted should contact the Executive Officer of UniSA HREC in the first instance, email: humanethics@unisa.edu.au or tel: 8302 3118.

If you are interested in participating in this study, please carefully read and complete the attached consent form and email it to the researcher. The researcher will then be in contact with you.

Participant Consent Form (SG2)

This project has been approved by the university of South Australia's Human Research Ethics Committee (ID '202622').

Project Title: Investigation of post-editing machine translation (PEMT) in advancing reading and writing capability of English and Chinese language learners in higher education

Researcher: Li-Ching Chang Email: li-ching.chang@mymail.unisa.edu.au

Principal Supervisor: A/Prof Kathleen Heugh Email: kathleen.heugh@unisa.edu.au

Co-supervisors: Dr Enza Tudini Email: enza.tudini@unisa.edu.au

Prof Ning Gu Email: ning.gu@unisa.edu.au

- I have received information about this postgraduate research project.
- I understand the purpose of the research project and my involvement in it.
- I acknowledge that my decision to take part (or not to take part or to withdraw from the study) will not influence my relationship with the researchers (and the institutions supporting this project) or my position/enrolment with my home University and my assessment/grades.
- I understand that I will be asked to fill out pre/post questionnaires.
- I understand that I will be involved in five one-hour tutorial discussions about the use of PEMT for research reading and writing. The discussion may include the translation problems I encounter and the solutions identified while doing PEMT. I can bring my translations/working texts to tutorial discussions.
- I understand that I will be invited to participate in an individual interview which will be audio-recorded and then transcribed by the researcher.
- I will not be identified and my personal details will remain confidential. I understand that no information which could lead to my identification will be released, unless as required by law.
- I understand that access to the collected data will be limited to the researcher and the researcher's university supervisors.
- I understand that all data (including audio recordings of the interviews and focus groups) will be stored securely (on the University of South Australia computer servers and in local filing cabinets) at the School of Creative Industries.
- I understand the statement in the information sheet concerning payment to me for taking part in an interview.
- I understand that I can discuss any ethical concerns about the research with UniSA Human Research Ethics Committee at 61-8-8302-3118 or : humanethics@unisa.edu.au
- I understand that I can discuss any other issues in relation to this research with the supervisors of the researcher via email provided above.

Name of participant: _____

Signed: _____ Date: _____

…….....

Office use only

I have provided information about the research to the research participant and believe that he/she understands what is involved.

Researcher's signature: _____ Date: _____

Appendix 4.6 Questionnaires (SG2)

Pre-intervention questionnaire (SG2)

I. Background information

1. Gender (Please identify your preferred gender identity):
2. Age range: 18-24 □ 25-34 □ 35-44 □ 45-54 □ 55 + □
3. Your home language(s):
4. Your second or additional language(s):
5. Your IELTS overall score or equivalent:
6. Your study program and/or research field:

II. Experience of using machine translation

1. Have you ever used free machine translation (MT) to support your English reading and writing processes? (MT, such as Google Translate, translates texts electronically.)
Yes □ No □

If yes, which MT do you use? (Tick all that apply.)
Google Translate □ Microsoft Translator □ Baidu □ Youdao □ Other □ _____

2. How frequently do you use MT in English learning for the following purposes? (Please circle a number.)

	Always	Almost always	Sometimes	Rarely	Never
2.1 Reading comprehension	5	4	3	2	1
2.2 Writing production	5	4	3	2	1
2.3 Translating words	5	4	3	2	1
2.4 Translating phrases	5	4	3	2	1
2.5 Translating sentences	5	4	3	2	1
2.6 Translating paragraphs	5	4	3	2	1
2.7 Translating a whole text	5	4	3	2	1
2.8 Checking what you read in English	5	4	3	2	1
2.9 Checking what you wrote in English	5	4	3	2	1
2.10 Any other purposes which are not listed above?					

Please answer the following items to tell me what you think about MT or post-editing of MT (PEMT).

	Strongly agree	Agree	Somewhat agree	Disagree	Strongly disagree
3. MT/PEMT can save time on course work.	5	4	3	2	1
4. MT/PEMT can produce more accurate course work.	5	4	3	2	1
5. MT/PEMT can increase confidence in reading.	5	4	3	2	1
6. MT/PEMT can increase confidence in writing.	5	4	3	2	1
7. MT/PEMT is helpful in English	5	4	3	2	1

learning.					
8. MT/PEMT is helpful in preparing course work.	5	4	3	2	1
9. MT/PEMT can strengthen my English reading.	5	4	3	2	1
10. MT/PEMT can strengthen my English writing.	5	4	3	2	1
11. Chinese translations from MT are accurate.	5	4	3	2	1
12. English translations from MT are accurate.	5	4	3	2	1
13. I always do post-editing or proofreading when I use MT.	5	4	3	2	1
14. I know how to do post-editing of MT appropriately.	5	4	3	2	1
15. I have the ability to judge whether the English translation from MT is accurate.	5	4	3	2	1

Post-intervention questionnaire (SG2)

I. Experience of using machine translation

1. Which MT do you use to support your English reading and writing? (Tick all that apply.)
Google Translate □ Microsoft Translator □ Baidu □ Youdao □ Other □ _____

2. How frequently do you use MT in English learning for the following purposes? (Please circle a number.)

	Always	Almost always	Sometimes	Rarely	Never
2.1 Reading comprehension	5	4	3	2	1
2.2 Writing production	5	4	3	2	1
2.3 Translating words	5	4	3	2	1
2.4 Translating phrases	5	4	3	2	1
2.5 Translating sentences	5	4	3	2	1
2.6 Translating paragraphs	5	4	3	2	1
2.7 Translating a whole text	5	4	3	2	1
2.8 Checking what you read in English	5	4	3	2	1
2.9 Checking what you wrote in English	5	4	3	2	1
2.10 Any other purposes which are not listed above?					

Please answer the following items to tell me what you think about MT or post-editing of MT (PEMT).

	Strongly agree	Agree	Somewhat agree	Disagree	Strongly disagree
3. MT/PEMT can save time on course work.	5	4	3	2	1
4. MT/PEMT can produce more accurate course work.	5	4	3	2	1
5. MT/PEMT can increase confidence in reading.	5	4	3	2	1
6. MT/PEMT can increase confidence in writing.	5	4	3	2	1

7. MT/PEMT is helpful in English learning.	5	4	3	2	1
8. MT/PEMT is helpful in preparing course work.	5	4	3	2	1
9. MT/PEMT can strengthen my English reading.	5	4	3	2	1
10. MT/PEMT can strengthen my English writing.	5	4	3	2	1
11. Chinese translations from MT are accurate.	5	4	3	2	1
12. English translations from MT are accurate.	5	4	3	2	1
13. I always do post-editing or proofreading when I use MT.	5	4	3	2	1
14. I know how to do post-editing of MT appropriately.	5	4	3	2	1
15. I have the ability to judge whether the English translation from MT is accurate.	5	4	3	2	1

II. Open-ended questions

1. Please write a few sentences or a paragraph to explain how you use PEMT.

2. In what ways do you think MT/PEMT is helpful in advancing your English reading and writing capabilities?

3. To what extent do you think this PEMT tutoring group is helpful?

4. Other comments?

Appendix 4.7 Rubrics for assessing translation

Angelelli's five-point-scale rubric for assessing translation (2009, p. 40-41)

T = translation; TL = target language; ST = source text

Source Text Meaning

5 T contains elements that reflect a detailed and nuanced understanding of the major and minor themes of the ST and the manner in which they are presented in the ST. The meaning of the ST is masterfully communicated in the T.

4 T contains elements that reflect a complete understanding of the major and minor themes of the ST and the manner in which they are presented in the ST. The meaning of the ST is proficiently communicated in the T.

3 T contains elements that reflect a general understanding of the major and most minor themes of the ST and the manner in which they are presented in the ST. There may be evidence of occasional errors in interpretation, but the overall meaning of the ST appropriately communicated in the T.

2 T contains elements that reflect a flawed understanding of major and/or several minor themes of the ST and/or the manner in which they are presented in the ST. There is evidence of errors in interpretation that lead to the meaning of the ST not being fully communicated in the T.

1 T shows consistent and major misunderstanding of the ST meaning.

Style and Cohesion

5 T is very well organized into sections and/or paragraphs in a manner consistent with similar TL texts. The T has a masterful style. It flows together flawlessly and forms a natural whole.

4 T is well organized into sections and/or paragraphs in a manner consistent with similar TL texts. The T has style. It flows together well and forms a coherent whole.

3 T is organized into sections and/or paragraphs in a manner generally consistent with similar TL texts. The T style may be inconsistent. There are occasional awkward or oddly placed elements.

2 T is somewhat awkwardly organized in terms of sections and/or paragraphs or does not flow together and has frequent awkward or oddly placed elements.

1 T is disorganized and lacks divisions into coherent sections and/or paragraphs in a manner consistent with similar TL texts. T lacks style. T does not flow together. It is awkward.

Situational Appropriateness

5 T shows a masterful ability to address the intended TL audience and achieve the translations intended purpose in the TL. Word choice is skilful and apt. Cultural references, discourse, and register are completely appropriate for the TL domain, text-type, and readership.

4 T shows a proficient ability in addressing the intended TL audience and achieving the translations intended purpose in the TL. Word choice is consistently good. Cultural references, discourse, and register are consistently appropriate for the TL domain, text-type, and readership.

3 T shows a good ability to address the intended TL audience and achieve the translations intended purpose in the TL. Cultural references, discourse, and register are mostly appropriate for the TL domain but some phrasing or word choices are either too formal or too colloquia for the TL domain, text-type, and readership.

2 T shows a weak ability to address the intended TL audience and/or achieve the translations intended purpose in the TL. Cultural references, discourse, and register are at times inappropriate for the TL domain. Numerous phrasing and/or word choices are either too formal or too colloquial for the TL domain, text-type, and readership.

1 T shows an inability to appropriately address the intended TL audience and/or achieve the translations intended purpose in the TL. Cultural references, discourse, and register are consistently inappropriate for the TL domain. Most phrasing and/or word choices are either too formal or too colloquial for the TL domain, text-type, and readership.

Grammar and Mechanics

5 T shows a masterful control of TL grammar, spelling, and punctuation. Very few or no errors.

4 T shows a proficient control of TL grammar, spelling, and punctuation. Occasional minor errors.

3 T shows a weak control of TL grammar, spelling, and punctuation. T has frequent minor errors.

2 T shows some lack of control of TL grammar, spelling, and punctuation. T is compromised by numerous errors.

1 T shows lack of control of TL grammar, spelling and punctuation. Serious and frequent errors exist.

Translation Skill

5 T demonstrates able and creative solutions to translation problems. Skilful use of resource materials is evident.

4 T demonstrates consistent ability in identifying and overcoming translation problems. No major errors and very few minor errors are evident. No obvious errors in the use of resource materials are evident.

3 T demonstrates a general ability to identify and overcome translation problems. However, a major translation error and/or an accumulation of minor errors are evident and compromise the overall quality of the translation. Improper or flawed use of reference materials may be reflected in the T.

2 T demonstrates some trouble in identifying and/or overcoming translation problems. Several major translation errors and/or a large number of minor errors are evident and compromise the overall quality of the translation. Improper or flawed use of reference materials is reflected in the T.

1 T reflects an inability to identify and overcome common translation problems. Numerous major and minor translation errors lead to a seriously flawed translation. Reference materials and resources are consistently used improperly.

Appendix 5.1 Pre- and post-intervention questionnaire data (SG1)

'NA' means no answers were received from students. The numbers in bold mean an increase in degree and those in shading mean a decrease in degree.

Pseudonym	Rory		Lisa		Maggie		Amanda	
Question/Statement	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1. Have you ever used free machine translation (MT) to support your Chinese reading and writing processes? If yes, which MT do you use?	No	Google Microsoft Baidu Youdao	Google	Google Microsoft Baidu Youdao	No	Google Baidu Youdao	Google	Google Baidu Youdao
2. How frequently do you use MT in Chinese learning for the following purposes?	Key: 5 – always; 4 – almost always; 3 – sometimes; 2 – rarely; 1 – never							
2.1 reading comprehension	2	2	3	3	**1**	**3**	3	3
2.2 writing production	**1**	**2**	**3**	**4**	**1**	**3**	3	3
2.3 translating words	**1**	**2**	4	4	**1**	**3**	4	3
2.4 translating phrases	**2**	**3**	**2**	**3**	**1**	**4**	3	3
2.5 translating sentences	**1**	**3**	3	3	**1**	**3**	4	3
2.6 translating paragraphs	1	1	**2**	**3**	**1**	**2**	4	3
2.7 translating a whole text	1	1	**1**	**2**	**1**	**2**	4	3
2.8 checking what you read in Chinese	**1**	**2**	3	3	1	1	3	3
2.9 checking what you wrote in Chinese	**1**	**2**	**3**	**4**	1	1	**2**	**3**
Students' opinions on MT/PEMT	Key: 5 – strongly agree; 4 – agree; 3 – somewhat agree; 2 – disagree; 1 – strongly disagree							
3. MT/PEMT can save time on course work.	3	3	4	4	NA	4	5	4
4. MT/PEMT can produce more accurate course work.	3	3	**2**	**3**	NA	3	3	3
5. MT/PEMT can increase confidence in reading.	3	3	**2**	**4**	NA	3	2	2
6. MT/PEMT can increase confidence in writing.	**3**	**4**	**2**	**4**	NA	3	3	3
7. MT/PEMT is helpful in Chinese learning.	**2**	**4**	3	3	NA	4	4	2
8. MT/PEMT is helpful in preparing course work.	**1**	**3**	4	4	NA	4	4	3
9. MT/PEMT can strengthen my Chinese reading.	3	3	**2**	**3**	NA	4	3	3

10. MT/PEMT can strengthen my Chinese writing.	**2**	**4**	**2**	**3**	NA	4	3	2
11. Chinese translation from MT are accurate.	**2**	**3**	2	2	NA	1	3	3
12. English translation from MT are accurate.	**2**	**3**	2	2	NA	1	3	3
13. I always do post-editing or proofreading when I use MT.	**4**	**5**	5	5	NA	5	5	5
14. I know how to do post-editing of MT appropriately.	**2**	**4**	**2**	**3**	NA	5	**2**	**4**
15. I have the ability to judge whether the Chinese translation from MT is accurate.	**2**	**3**	**3**	**4**	NA	3	3	3

Appendix 6.1 Pre- and post-intervention questionnaire data (SG2)

'NA' means no answers were received from students. The numbers in bold mean an increase in degree and those in shading mean a decrease in degree.

Pseudonym	Qing		Yun		Lian		Ying		Peng		Xiang	
Question/Statement	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1. Have you ever used free machine translation (MT) to support your English reading and writing processes? If yes, which MT do you use?	No	Google Eudic	Google	Google	Google Youdao	Google Youdao	Youdao	Google Youdao	Google Micros Baidu Youdao	Baidu Youdao	Google Youdao	Google Baidu Youdao
2. How frequently do you use MT for the following purposes?	Key: 5 – always; 4 – almost always; 3 – sometimes; 2 – rarely; 1 – never											
2.1 reading comprehension	**1**	**3**	3	3	**3**	**4**	3	3	**3**	**5**	**3**	**4**
2.2 writing production	**1**	**3**	3	3	3	3	4	3	5	4	**3**	**4**
2.3 translating words	**1**	**3**	**3**	**4**	4	4	**3**	**4**	5	5	**4**	**5**
2.4 translating phrases	**1**	**4**	3	3	4	3	3	3	5	4	**3**	**5**
2.5 translating sentences	**1**	**3**	**3**	**4**	4	3	3	3	4	3	3	3
2.6 translating paragraphs	**1**	**3**	**2**	**4**	4	3	2	2	4	2	2	2
2.7 translating a whole text	1	1	**2**	**4**	**2**	**3**	2	2	4	2	**1**	**2**
2.8 checking what you read in English	**1**	**3**	**2**	**4**	**2**	**4**	3	3	3	3	3	3
2.9 checking what you wrote in English	**1**	**3**	**2**	**4**	**2**	**4**	4	3	**3**	**4**	**3**	**4**
Your attitudes towards MT/PEMT	Key: 5 – strongly agree; 4 – agree; 3 – somewhat agree; 2 – disagree; 1 – strongly disagree											
3. MT/PEMT can save time on course work.	NA	5	**3**	**4**	4	4	4	4	**4**	**5**	5	4
4. MT/PEMT can produce more accurate course work.	NA	3	**3**	**4**	4	4	4	4	**4**	**5**	**3**	**4**
5. MT/PEMT can increase confidence in reading.	NA	4	**3**	**4**	4	3	4	4	**3**	**4**	4	4
6. MT/PEMT can increase confidence in writing.	NA	3	**2**	**3**	4	3	4	3	4	4	4	4
7. MT/PEMT is helpful in English learning.	NA	3	**2**	**5**	4	4	4	4	5	5	4	4

8. MT/PEMT is helpful in preparing course work.	NA	3	**2**	**5**	3	3	4	4	4	4	4	4
9. MT/PEMT can strengthen my English reading.	NA	3	**3**	**4**	3	3	4	4	5	5	**3**	**4**
10. MT/PEMT can strengthen my English writing.	NA	3	**3**	**4**	3	3	4	4	3	3	4	4
11. Chinese translation from MT are accurate.	NA	3	**2**	**3**	3	3	3	3	3	3	**3**	**4**
12. English translation from MT are accurate.	NA	3	**2**	**3**	**2**	**4**	3	3	3	3	**3**	**4**
13. I always do post-editing or proofreading when I use MT.	NA	4	**2**	**4**	**2**	**4**	**3**	**4**	5	4	5	4
14. I know how to do post-editing of MT appropriately.	NA	3	**3**	**4**	**2**	**4**	3	3	4	4	**3**	**4**
15. I have the ability to judge whether the English translation from MT is accurate.	NA	4	4	4	**3**	**4**	4	4	5	4	**3**	**4**