第５章

Use of Machine Translation among EFL Japanese Graduate Students in STEM Disciplines: Perceptions and Beliefs

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Abstract

This action research examines the perceptions and use of machine translation (MT) among 39 STEM major graduate students learning English as a foreign language (EFL) at a Japanese university. Our survey data shows that the focal Japanese graduate students in STEM fields are underprepared for the level of English proficiency expected in higher education. Therefore, MT steps in as a learning tool to scaffold their writing process in the L2. However, graduate students lack strategies to use machine translation efficiently and ethically, which negatively impacts their English learning processes, the translation quality of the yet-improving technology, and ultimately their knowledge construction. We argue that universities in EFL contexts should have clear guidelines on ethical MT use, and EFL/ESP instructors should consider integrating guided instructions of MT in accordance with the school policy, curriculum, and student goals.

1. Introduction

English has become the lingua franca for knowledge construction in science in the 21st century. In Japan, there has been an increased demand for graduate students and scholars to publish in English for graduation, research publication, and tenure purposes. Meanwhile, as most graduate students fail to attain the required proficiency to receive instructions entirely in English, Japanese remains the primary medium of instruction in most STEM classes. The continual lack of input and meaningful production

practice in the classroom creates an environment unconducive to English learning. Nevertheless, MacDowell and Liardét (2019) reported that material scientists in their study published five times more in English than in Japanese, even though their limited knowledge of English grammar and vocabulary consistently made writing a grueling process that cut into their research time.

In late 2016, the technology driving MT underwent a paradigm change to neural machine translation (NMT), which relied on artificial neural networks to provide translations with higher accuracy. For many junior scholars, the paradigm change has presented new opportunities to write and publish in English. Consequently, many of them have started using machine translation. This pilot study aims to address this issue by examining the perceptions and use of machine translation among EFL graduate students in STEM at a Japanese university. The paper is structured as follows: Section 2 offers a review of previous literature on machine translation (MT) and language instruction in the Japanese and international contexts; Section 3 introduces the research design and methods; Section 4 presents the results and discussion; and Section 5 concludes the paper.

2. Literature Review

2.1 Machine Translation (MT) research in Japan

Researchers in Japan have explored the benefits and drawbacks of and reality of MT use in foreign language instruction (FLI) because MT has been ubiquitous in society and FLI cannot ignore its influence on students learning foreign languages, including English (Narita, 2019; Oda, 2021; Tsutada, 2019; Yanase & Leeds, 2022). Narita (2019) demonstrated the strengths and weaknesses of different MT applications and suggested the inevitability of MT use in FLI and techniques for effective MT use, such as pre- and post-edits of L1 text before translating it through MT. Tsutada (2019) instructed a translation project with seven sequential tasks using

MT to the Japanese EFL undergraduate students in her translation course. The students understood the use of MT and could formulate rules for effective MT use; therefore, she argued for cultivating MT literacy among students. Yanase and Leeds (2022) at Kyoto University analyzed error types produced by MT among 33 1st- and 2nd-year undergraduate students' original and MT version writings, with 1,265 words per essay on average. They found syntactic and semantic types of linguistic imprecision in MT. These problems include (A) syntactic problems: (1) singular/plural problems and (2) improper subject fulfillment; and (B) semantic problems: (3) non-literal expressions (e.g., metaphors), (4) loan words, and (5) partial correspondence (partial overlap of meaning across languages). They assumed that everything could not be solved by machine translation, and writers needed to critically read the output of MT for discrepancies with the intended content. The authors also emphasized that the ubiquity of MT entailed a discussion on its use in English education. They predicted that it was impossible to stop the expansion of MT use, stating that the focus on producing English that accurately expresses the learner's intended meaning would shift from "writing" to "editing" English, that is, "critical close reading and close rewriting" (p. 66). Oda (2021) surveyed teachers and found that foreign language teachers should establish the guidelines for MT use through discussions of guided use of the machine translation (GUMT) in FLI.

2.2 MT research outside of Japan

Research on machine translation outside of Japan has mainly focused on its deficiency (Luton, 2003; McCarthy, 2004), the detection and prevention of academic dishonesty (Correa, 2011; Steding, 2009), student beliefs and teacher beliefs (Jolley and Maimone 2015; Niño, 2009; White & Heidrich, 2013), and pedagogical interventions (Lee, 2019; Lee & Briggs, 2021; O'Neill, 2016, 2019a, 2019b; Ryu et al., 2022). Owing to

space limitations, we have only reviewed some of the recent papers on pedagogical interventions that inform our research. For a comprehensive review, we refer the reader to Jolley and Maimone (2022).

2.2.1 Emergence of Neural Machine Translation (NMT)

The introduction of NMT by Google significantly increased the accuracy of machine translation and its ability to serve as an additional language learning tool for EFL learners. O'Neill (2019a, 2019b) investigated the impact of MT and online dictionaries on the writing of 310 intermediate learners of French and Spanish, who were split into five groups: (i) Google Translate with prior training, (ii) Google Translate with no prior training, (iii) WordReference with prior training, (iv) WordReference with no prior training, and (v) control. During the experiment phase, the Google Translate groups outperformed the WordReference groups. In addition, both the Google Translate and WordReference groups that received prior training outperformed their untrained counterparts. However, during the post-test and delayed post-tests, where none of the five groups were allowed to use tools, the positive effects of Google Translate and WordReference could no longer be detected.

Lee (2019) studied 34 English majors in a multimedia-assisted language learning course at a Korean university. The participants completed a one-page writing task in L1 Korean. Subsequently, they translated the Korean source text into English on their own. Participants were then instructed to translate the Korean source text using MT. Participants were asked to revise their initial English translation after comparing it with the MT output. Quantitative data showed that the writing quality of the final edited versions had considerably improved. A significant decline in the average number of lexical errors and grammatical errors was detected. Data collected from interviews and reflection papers also revealed that participants selectively adopted suggestions made by MT. The

participants commented that word choices made by MT were more contextualized than the choices provided by a dictionary, and they selected the word that best fit the context after comparing their own choice with MT's selection. When MT offered an alternative sentence structure, participants reevaluated their own grammatical constructions and made appropriate changes. Students with lower proficiencies rated the MT experience more positively. Lee argued that the experiment task was similar to a peer-editing session, in which MT served as a peer and provided suggestions for lexical and grammatical revisions. The author mentioned MT's inability to provide feedback on macro-level discourse as the only downside.

Lee and Briggs (2021) investigated the correction of lexical and grammatical errors made by 58 Korean college students during post-editing. The results of the study showed that word-level changes occurred most frequently during post-editing. This suggested that Korean EFL learners treated MT output as corrective feedback. Students with higher proficiency levels were better at detecting their own errors when comparing their own translations to MT output.

Ryu et al. (2022) reported on students' perceptions of the GUMT model and its effectiveness. This study adopted a structured and guided approach to MT to better support students with lower proficiencies. The study spanned one entire semester, and 43 out of 48 students from two sections of third-semester Korean (high-beginner/low intermediate) at a large southwestern U.S. university participated in the study. The study began with a 50–min instructional session of GUMT, in which students learned about the strengths and weaknesses of MT and were taught to crosscheck the pragmatic appropriateness of MT output with Google Images and Google News. Students applied the GUMT model in five writing assignments throughout the semester. In the post-survey, most students reported that the GUMT model had taught them strategies to effectively use MT

and that they would continue their practice of using MT in the future. Students also stated that the model had raised their metalinguistic awareness of Korean. The results revealed that with guidance, lower-level students could appreciate MT as a consulting and self-assessment tool.

3. Research Design and Methods

3.1 Research questions

The previous studies have convincingly shown that MT can improve learners' writing quality by playing the role of a "peer" and suggesting alternative revisions in the post-editing phase. Instructional workshops on MT use can also help learners use MT efficiently. Against this backdrop, we aimed to learn more about how Japanese graduate students in STEM fields use MT tools in their academic work. We explored the following research questions:

RQ 1: What are participants' perceptions of MT's helpfulness?
RQ 2: How do participants use MT in their graduate study?
RQ 3: What are participants' attitudes, beliefs, and perceptions regarding their instructors' responses to students' use of MT?
RQ 4: What are learners' attitudes, beliefs, and perceptions of MT as a learning tool before and after a machine translation workshop?

3.2 Participants

The participants were 39 first-year graduate students in an MS program enrolled in one of the authors' EFL courses. At the time of the study, their English proficiency fell on the CEFR[1] A2 level. According to the CEFR Global Scale (Council of Europe, n.d.), A2-level language learners are

[1] CEFR is the abbreviation of Common European Framework of Reference for Languages: Learning, Teaching, Assessment. The authors refer to CEFR for the description of the participants' English proficiency level rather than indicating the name of an English proficiency test taken by the participants to maintain the participants' anonymity.

basic users who can understand and communicate their immediate needs or personal interests through everyday expressions and simple and direct exchange of information. The participants only had limited English grammatical and lexical knowledge. However, they were required to read research papers and write conference proposals and lab reports in English, despite their difficulties. At this institution, Japanese is the medium of instruction in most graduate courses, except for a few courses with English as a medium of instruction taught by international faculty members. Despite their limited English competency and exposure to English-using opportunities, the participants had a specific need to learn English for their research activities in STEM fields.

3.3 Data collection

3.3.1 MT tasks through a presentation project

Through a research presentation project with a series of in-class Japanese-English translation tasks with MT, the authors collected data for analysis in the first semester of the 2022 academic year. One of the authors offered a 90–min instructional session on speech writing and a 90–min instructional workshop on the guided use of MT. Unlike O'Neill (2019) and Ryu's (2022) guided approaches to MT, which taught crosschecking techniques for identifying lexical issues using online dictionaries, Google images, and Google news, the authors of the present study did not teach these techniques in this pilot study because of the limited class time toward the end of the semester. Instead, we wanted to respond to O'Neill's (2019) call for more investigations into the impact of MT on specific grammatical features. Therefore, during the MT workshop we designed, we provided instructions on a couple of key grammatical features in Japanese that MT has difficulty with: topic-comment structure and omission of subjects and objects. Students were given instructions on pre-editing strategies, such as using appropriate punctuations, avoiding lengthy sentences, and cross-

checking technical terms using their textbooks.

3.3.2 Pre- and Post-surveys

Pre- and post-surveys in Japanese were conducted to capture students' perceptions of MT, in general, and the guided use of MT. The pre-survey included yes-no questions, questions to solicit the participants to explain their responses, and open-ended questions. The post-survey included one yes-no question and four open-ended questions. The former received 39 responses, and the latter received 31 responses[2].

3.3.3 Sequential Tasks

Between the pre- and post-surveys, the students were given eight tasks: (1) participating in a workshop about speech draft writing in Japanese, (2) speech draft writing in Japanese, (3) manually translating their Japanese speech draft into English, (4) participating in an instructional workshop on the guided use of MT, (5) editing their Japanese manuscript to ensure accurate MT translation (pre-editing), (6) using MT to translate their Japanese manuscript into English, (7) comparing their manually translated version of the speech draft with the MT version, and (8) editing their own translation after reading the MT output (post-editing). Depending on their preference, participants were allowed to use either Google Translate or DeepL when translating their Japanese speech draft into English. The detailed sequence of our study with Japanese-English translation tasks in the students' research presentation project is as follows:

[2] 21 students in Class A and 18 students in Class B responded to the pre-survey. 18 students in Class A and 13 students in Class B responded to the post-survey.

Pre-survey: Participants responded to a pre-survey with 19 questions about their use of MT.

Task 1: Participants attended a 90–min writing workshop about how to explain, in Japanese, a research topic concisely to a non-specialist audience, such as their friends, family members, or juniors who wish to enter a graduate program in STEM fields.

Task 2: Participants wrote their speech draft in Japanese as a homework assignment.

Task 3: Participants manually translated their Japanese speech draft into English in the 90–min class session.

Task 4: Participants participated in a 90-min MT workshop, where one of the authors explained selected linguistic differences between Japanese and English and problems with MT caused by such differences and instructed them on how to utilize MT for research-related English writing with such meta-language knowledge of Japanese and English.

Task 5: Participants edited their Japanese manuscript to ensure accurate MT translations.

Task 6: Participants translated their Japanese speech draft into English with MT.

Task 7: Participants compared their manual translation of the speech draft and the MT version.

Task 8: After consulting the MT output, participants edited their manual translation by making grammatical and lexical changes.

Post-survey: Participants responded to a post-survey with five questions about their experience with the guided use of MT.

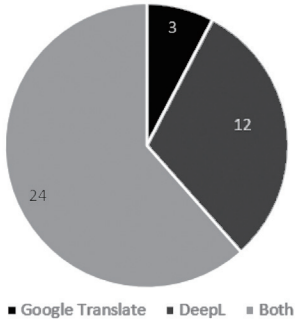
4. Results and Discussion

After the tasks, the authors examined the pre- and post-survey results and thematically coded and analyzed them. This section reports and discusses our findings from the survey responses in relation to our research questions.

4.1 RQ1 What were participants' perceptions of MT's helpfulness?

All 39 respondents to the pre-survey reported that they had previously used MT. Twelve of our participants used DeepL, and three of them used Google Translate. The remaining 24 participants used both DeepL and Google Translate, and one of these participants added that they used Weblio sometimes.

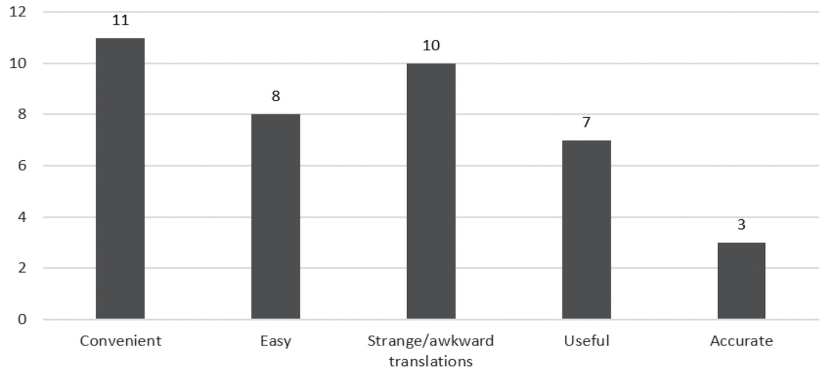
Figure 1.
MT tools used by graduate students in STEM



When participants expressed their opinions on MT, several words and phrases such as "convenient," "easy," "useful," "accurate," and "strange/awkward translations" appeared in our survey responses multiple times. Figure 2 shows the number of times each word or phrase appeared. The chart shows that participants use MT because of its convenience and ease of use. A few respondents commented that MT is a more efficient tool for looking up word meanings than paper or online dictionaries, especially in

cases where the student did not know multiple words in the same sentence. One participant also noted that MT could sometimes select the best meaning of a word based on the context. Some participants explained that they used MT to read academic articles to get gist translations of the texts, which might explain the frequent appearance of the keyword "useful" in their responses. However, except for a few students who commented that they were surprised at the accuracy of DeepL, most participants had reservations about the quality of MT translations. For example, respondents complained about MT's inability to parse sentences with subjects and objects omitted for discourse-related reasons in Japanese. In those cases, the gender-neutral *they* or *it* was added. Some respondents also complained that when copying and pasting directly from a PDF file, MT considered line breaks as sentence endings and translated each line as a separate sentence. Furthermore, participants also expressed that it was difficult for them to pre-edit their Japanese input for MT, and some of them were concerned that they lacked the English proficiency to verify the accuracy of MT output.

Figure 2.
Number of times recurring descriptors appeared in survey responses

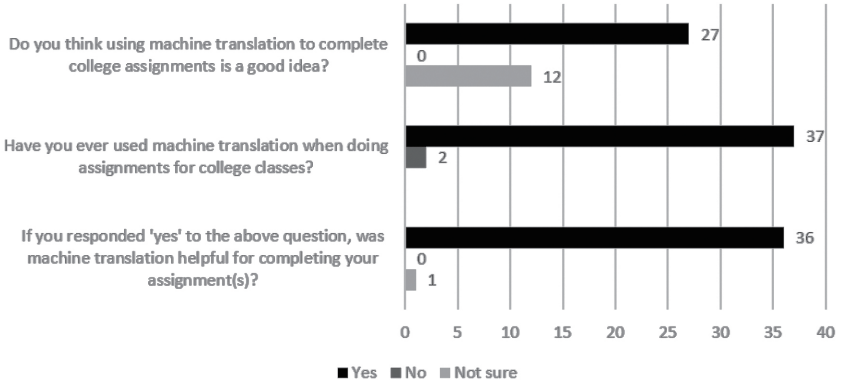


In sum, participants found machine translation tools to be helpful, despite their concerns about the accuracy of MT output. Nonetheless, participants did not possess the skills to use MT tools effectively. Thus, instructors need to teach them about the strengths and weaknesses of MT and appropriate pre-editing strategies to work around the weaknesses of different MT tools to enable learners to maximally utilize the benefits of MT.

4.2 RQ2 How did participants use MT in their graduate study?

Most participants (N=27) considered it ethical to use MT for college assignments. Although 12 respondents felt ambivalent about using MT for their coursework, none of our 39 participants believed that it was wrong. In addition, 37 out of our 39 participants reported MT usage in past assign-ments, and all but one of them felt that MT was helpful for completing assign-ments.

Figure 3.
Participants' perceptions of MT before the instructional workshop



Our survey responses also showed that most students used MT tools in their field-specific coursework, and only a few students used them for English assignments. Most students used MT to look up words, crosscheck their self-constructed English sentences, or translate English instructions and texts into Japanese to aid their comprehension. A few students admitted that they had translated a few sentences with MT and copied and pasted them into their assignments before. Only one respondent disclosed that they had once composed a draft in Japanese and translated the entire text into English, but they did not specify the class for which the assignment was written. Many respondents commented that the use of machine translation tools reduced the number of mistakes and helped them construct sentences that they would have found difficult to write, given their limited proficiency. The efficiency of MT was brought up several times in our survey responses, as exemplified by the following quotes:

> "[…] *I was able to complete [the assignment] in about a tenth of the time it would take me to solve it using a dictionary. If I were to do [a] long reading now, it would take me more than an hour to even read an A4 size 1–page material. If I use machine translation, I can spend that time doing something else."*

> *"In order to improve my English skills, I should really think and write by myself. However, I have many assignments and lab reports for my other classes, and I cannot devote time to my English studies. It is just an excuse, but I also think I cannot help but use MT in order to meet the submission deadline of each assignment."*

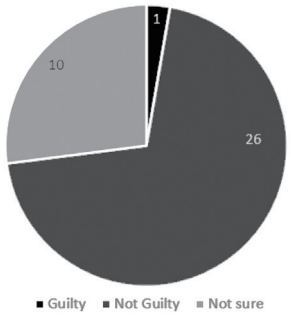
Regardless of the second comment that opined their inability to devote time to studying English was an excuse, it must be stated that Japanese graduate students in STEM fields lead extremely hectic lives. Even in the

first semester of their graduate study, students typically have a maximum course load and must begin their research project and job search immediately. As much as they want to improve their English, the practical realities severely constrain their investment (Norton Pierce, 1995). Therefore, MT allows graduate students to complete their assignments in English without compromising their other priorities.

4.3 RQ3 What are participants' attitudes, beliefs, and perceptions regarding their instructors' responses to students' use of MT?

We asked participants for their perceptions of how their instructors may react if they learned about their MT use. Most students responded that because they had never used MT in a language class, their instructors would not be upset about their MT use.

Figure 4.
Students' self-report of guilt (or lack thereof) when using MT



We also asked if our participants felt guilty about their MT use in their coursework. Only one student answered in the affirmative. Most of our respondents (N=26) reported that they did not feel guilty when using MT for their coursework, while 10 respondents were unsure. The respondents' overall perceptions were understandable. Most of them used MT to look up words, crosscheck their own writing, verify their understanding of a

text, and so on. The survey responses showed that most students did not feel that instructors would be against such uses. In fact, some respondents even stated that their professors actively encouraged the use of MT in their academic reading and writing processes.

A discussion is warranted for the individual who admitted that they had once prepared a self-composed text translated by MT. It would be a clear violation of the academic code if the text was submitted as an assignment for a language class, as discussed in previous work on MT and academic dishonesty (McCarthy 2004; Correa 2011, 2014). However, if it was a submission for a STEM class, it would be debatable whether that constituted academic dishonesty. After consulting multiple colleagues, the authors found that even college instructors have different opinions on the issue. Furthermore, as Ducar and Schocket (2018) aptly indicated, academic codes at most institutions are flexible and "purposely do not include an exhaustive list of possible violations, or consider intent, or the lack thereof, as necessary to determine guilt" (p.788). We believe that course instructors and institutions should have clear policies regarding the use of machine translation in non-language courses.

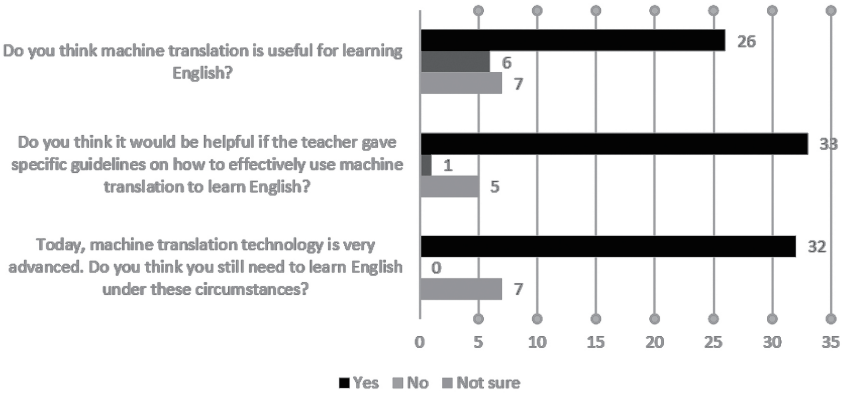
4.4 RQ4 What are learners' attitudes, beliefs, and perceptions of MT as a learning tool before and after the workshop?

Prior to the workshop, most participants (N=26) had already viewed MT as a useful learning tool. Many of them believed that they could "deepen [their] understanding by comparing the machine translation [output] with [their] own translation[s]" and learn new idioms and expressions in English. This observation by students clearly showed that they saw the potential of MT as a learning tool based on their past experiences. Lee (2019) argued that MT could act as a peer and provide alternative suggestions. This claim is supported by our participants' claim that they learned new phrases and idioms from MT output. One student

also pointed out that MT lowered the "barrier [they felt] against English," echoing a similar claim by Lee and Briggs (2021) that MT reduced students' cognitive load and made the L2 writing process less overwhelming. Regarding the remaining respondents who did not consider MT a learning tool (N=6) or expressed uncertainty about its effectiveness in supporting their learning (N=7), the source of their doubt was errors in the translations provided by MT. A couple of students remarked that even "lousy" English or Japanese texts could be translated by MT, and learners might not have the proficiency to verify the accuracy of the translations. These responses revealed a significant difference between the language produced by students individually and that generated by MT. This is consistent with Ryu et al.'s (2022) claim that lower-level students need guidance on MT to appreciate it as a self-assessment tool.

Most participants (N=33) felt that instructions from teachers on MT use would be beneficial for their English learning. Some of them admitted that they sometimes copied and pasted entire sentences directly from MT to their coursework. Therefore, they responded positively to a workshop on using MT as a tool to learn English, as they did not want to develop an overreliance on MT or "use machine translation without thinking." One student also felt that instructions would be helpful as they wanted to understand what their instructors considered as ethical uses of MT. Based on the survey responses, it was evident that students felt trapped in a situation in which they lacked the proficiency to conduct academic work in English but were required to do so. Consequently, many of them resorted to copying and pasting complete sentences from MT, even though they did not want to abuse the tool and had questions about the ethicality of such an act.

Figure 5.
Participants' views on MT as a learning tool before the workshop

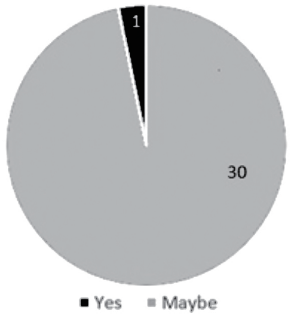


As MT technology has become more advanced and most of our participants were learning English for their professional development, we asked if they still considered English learning essential with MT at their disposal. Most participants (N=32) felt that it was necessary to learn English; only 7 participants felt uncertain. A small number of respondents noted that MT could not help them with real-time conversations, and they would need to be proficient in English to check for inaccuracies in MT output. A few comments were regarding MT's inability to translate subtle nuances. Many respondents believed that they needed to improve their English to go abroad to share their knowledge with other international scholars. The responses to this question illustrate the uncomfortable situation in which scholars outside of English-speaking countries find themselves. As English is the lingua franca for knowledge construction, native English-speaking scholars enjoy an advantage because they do not have to learn a different language to participate in academic discourses. For the Japanese graduate students in our study who did not have time to improve their English proficiency, MT reduced the language barrier and provided them with an opportunity to share their knowledge. Simultaneously,

academic manuscripts filtered through MT technology might contain inaccuracies and mistranslations, thereby negatively affecting knowledge construction. Guided instructions on effective MT use can alleviate this problem.

During the 90–min MT workshop, we gave instructions on pre-editing strategies and a few key grammatical features in Japanese that MT has difficulty with: topic-comment structure and omission of subjects and objects. Only 31 participants responded to the post-survey after the workshop. All participants, except one who answered "maybe," considered the workshop to be helpful.

Figure 6.
Participants' perceptions of the effectiveness of the MT workshop



The post-survey results show that the workshop helped many respondents understand that subjects are obligatory in most English sentences, but syntactic arguments that are linked to a discourse topic can be dropped in Japanese. When learners enter Japanese sentences with empty arguments (subject, object, indirect object) into MT, a gender-neutral pronoun (*it* or *they*) is assigned to those argument positions. It has been reported that early EFL learners, not knowing that English is a subject-prominent language, also dropped their arguments when speaking English (Wakabayashi 2002). Therefore, instructors can use "MT as a bad example"

(Niño 2009, p. 242) to teach learners about the linguistic differences between English and Japanese. Many respondents also commented that it was helpful for them to learn about the topic-comment structure in Japanese so that they could distinguish between a subject and topic in their first language. Understanding the difference between the topic (marked with the suffix -wa) and subject (marked with the suffix -*wa* or -*ga*) is important, especially when the Japanese sentence contains an empty subject. When such a sentence is filtered through MT, MT usually misinterprets the topic as the subject. Such a comparison of English and Japanese promotes students' metalinguistic awareness. Many of our respondents felt that they had learned more about the weaknesses of MT and acquired better MT pre-editing strategies from the workshop. They learned to check for subjects, use punctuation, and shorten lengthy sentences in their original Japanese sentences when using MT.

4.5 Pedagogical Implications

Our survey data shows that Japanese graduate students in STEM fields use MT tools frequently to complete their coursework. However, their lack of strategies to efficiently use MT negatively impacts the translation quality of the yet-improving technology and their knowledge construction. Despite the ubiquity of MT among Japanese college and graduate students, a recent study by Oda (2021) found that 63.3% of Japanese EFL instructors did not discuss the use of MT in their classes. We believe that ignoring the existence of MT does a grave disservice to Japanese graduate students. EFL instructors in Japan must consider how to integrate MT into their classrooms and decide which MT strategies will best serve the needs of their EFL classes.

As our graduate students mainly use MT for research presentation and publication purposes, Japanese universities and STEM programs should clarify their stance on students' MT use. Graduate students should have

clear guidelines on the ethical use of MT in STEM research. It may also be helpful for STEM programs to require graduate students to take English for Specific Purposes (ESP) composition classes. Successful international scholars should understand discipline-specific writing conventions and rhetorical styles. Effective use of MT can serve as scaffolding for students' learning of English, but it should not be a means to an end.

5. Conclusion

This action research examined the perceptions and use of machine translation among 39 STEM major graduate students learning EFL at a Japanese university. Our survey data shows that Japanese graduate students in STEM fields are underprepared for the level of English proficiency expected in higher education. Therefore, machine translation steps in as a learning tool to scaffold their writing in the L2. However, students' lack of strategies to efficiently use machine translation negatively impacts the translation quality of the yet-improving technology and their knowledge construction. We argue that Japanese universities should have clear guidelines on ethical machine translation use, and EFL/ESP instructors should consider how to integrate machine translation in accordance with the school policy, curriculum, and student goals.

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