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The Roles of Machine Translation in Learning Among K-12 Students at the International Schools in the Great Bay Area, China

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Abstract

Intercultural foreign language learning among K -12 students at international schools involves the cross-cultural discovery of the changing habits of people whose mother tongue might be different instructive languages at schools. Bilingual education is essential in bridging the gap between the mother tongue and instructive languages. However, it needs effective strategies that combine in-classroom language learning with new technology. Several language learning and teaching trends concerning the digital environment and innovative technologies such as machine translation or digitalization are currently challenging K-12 schools and families. This research investigates the role of machine translation in learning among K-12 students at international schools in the cities of Shenzhen, Guangzhou, and Zhuhai. It aims to identify these gaps in existing research and propose innovative strategies for boosting learning outcomes to recognize the learning habits they developed as young learners in the 21st century and their cultural motivations. Bilingual surveys are being handed out to K-12 families. These surveys are written in both English and Chinese. In total, 221 of them were collected. The data was analyzed to examine how helpful machine translation is for academic learning in both languages. The strengths and weaknesses were summarized among K-12 students using machine translation, highlighting strategies used with it at international K-12 schools.

Keywords: Conceptual, English curricula, Intercultural, Technology, 21st century

1. Introduction

The world has been getting bigger and bigger. International schools are starting to stand out as a place for kids to learn without sacrificing exploration or the diverse student body they have grown to love. These schools have a systemic approach to promoting cross-cultural interactions (Lai et al., 2019). One of their main focuses is on foreign language acquisition so students can understand each other better (Le Pichon et al., 2024). In regions such as Asia, international schools hold particular significance due to the complex intersection of diverse cultures and languages. For instance, South Asian countries, including Bangladesh, Nepal, Pakistan, and Sri Lanka, have witnessed an increase in K-12 computing education emphasizing technology integration into the curriculum (Anwar et al., 2020), highlighting the essential role digital literacy plays in today's interconnected world.

Similarly, international schools on the African continent have been instrumental in promoting English language proficiency among Black English learners by adopting a holistic approach that prioritizes linguistic skills and cultural understanding (Cooper, 2020). Furthermore, Turkish schools' incorporation of Information and Communication Technology (ICT) into K-12 education underscores the worldwide shift towards technology-driven educational paradigms (Aydin et al., 2016). As these institutions continue evolving globally, they play an indispensable role in shaping future generations of global citizens proficient at bridging cultural divides while leveraging technology for learning purposes.

Despite traditional classroom settings being long considered integral to K-12 education with their emphasis on face-to-face instruction, rapid technological advancements highlight its potential for enhancing learning outcomes, especially within language acquisition domains. As Zhang et al.(2021) highlighted, online supplementary platforms offer valuable insights into student behavior through data analysis, offering opportunities for machine-learning-aided interventions to address issues like bullying, thereby creating safer, conducive environments. One critical technological innovation transforming this area is machine translation tools, which provide instant translation between different languages, holding great potential within multicultural classrooms.

However, using tools like these in International schools has yet to be explored much. This research seeks to do just that with three cities: Shenzhen, Guangzhou, and Zhuhai. These places are hubs of international education. Kids growing up nowadays are experts at using all sorts of technology and have been dubbed digital natives. To leverage this skill, they can use interactive platforms like games to learn concepts like machine learning. It also enhances understanding and motivation for younger learners (Priya et al., 2021). Given how their Education systems are bilingual, it is essential to understand their habits around using machine translation tools.

Given this context, this study analyses how Machine Translation contributes to development amongst K-12 students attending International Schools. By conducting bilingual surveys alongside rigorous statistical analysis, we aim to elucidate efficacy proficiency levels and advantages and drawbacks associated with MT techniques employed across global scale Education systems.

The purpose of this study is to examine what and how machine translation contributes to K-12 students attending international schools in the Great Bay Area, China.

2. Literature Review

Machine learning technologies, particularly machine translation (MT), have become increasingly integral in educational settings, fundamentally altering the dynamics of language learning and teaching (Priya et al., 2022). The pervasiveness of these technologies underscores the necessity for students to be adept in their use, preparing them for a progressively digital era. Clifford et al. (2013) highlighted that students extensively use MT for various purposes, including translating from English into the target language and understanding complex linguistic elements such as idiomatic expressions and verb tenses. Recent studies have expanded on these findings. Powell et al (2022) discovered a positive correlation between the use of MT and its perceived benefits in academic settings among graduate students in South Korea. Their research suggests that students are increasingly relying on MT for significant academic work and daily tasks, indicating MT's growing role in educational support.

However, the integration of MT in language education has its challenges. Klekovkina (2022) and Zhang et al. (2021) emphasize the critical perspective students develop toward MT outputs, recognizing that MT often makes choices for them and may not always provide the 'correct' version. This awareness underscores the importance of human interaction in language learning, suggesting that over-reliance on technology could be detrimental to the learning process. Tafazoli (2023) provides a critical appraisal of Artificial Intelligence (AI)-mediated communication in language education, including MT, highlighting both the advantages and disadvantages. The study argues the necessity for language teachers to continually adapt and improve their teaching strategies to incorporate these advanced tools effectively.

Urlaub and Dessein (2022) discuss the transformative potential of online MT tools in foreign language education, emphasizing the need for pedagogical tools based on MT that acknowledge and can handle socio-culturally complex source texts. They advocate for research and development priorities that focus on optimizing support for language learners through technology. Jolley and Maimone (2022) offer a comprehensive review of three decades of research on MT in foreign language teaching and learning. Their analysis provides historical context, summarizing key concepts, insights, and findings and suggesting new directions for future research. The review emphasizes the diverse ways learners use MT tools and the varying perceptions instructors and learners have about MT, informing strategies for its integration into language education.

3. Methodology

The primary objective of this research was to investigate the role and impact of machine translation in the context of K-12 international schools in the Great Bay Area, China. A structured questionnaire was designed and distributed to a diverse group of stakeholders associated with these schools. A total of 221 participants took part in the survey. The participants comprised students, teachers, parents, and others associated with K-12 international schools in the Great Bay Area. The majority of the respondents were parents (46.61%), followed by students (34.39%), teachers (15.84%), and others (3.17%). The survey consisted of 16 questions, which were designed to gather both quantitative and qualitative data. The questions were framed to understand:

- The participants, including their role concerning the K-12 international schools, city of residence, and primary language;
- The frequency and effectiveness of machine translation tools in the context of learning or teaching;

- The impact of machine translation tools on learning habits, classroom environment, and motivation to learn new languages;
- The perceived future role of machine translation in learning and the level of support for its increased use in classrooms;
- Familiarity and effectiveness of AI language models like ChatGPT in aiding learning or teaching;

The questions were primarily closed-ended, using a Likert scale format, where participants rated their responses on a scale of 1 to 5. However, the last question (Question 16) was open-ended, allowing participants to provide a qualitative explanation for their answer to Question 15. Quantitative data from the survey were analyzed using descriptive statistics to determine frequencies, percentages, and mean scores for each question, which provided a comprehensive overview of the participant's perceptions and experiences related to machine translation tools and AI language models in the educational context. The qualitative data from Question 16 were analyzed thematically to identify common themes and patterns in the participants' explanations. While the survey provides valuable insights into the role of machine translation in K-12 international schools in the Great Bay Area, it is essential to note that the findings are based on the perceptions and experiences of the participants and may not be generalizable to other contexts or regions.

4. Research Analysis

Chart 1:

Roles in K-12 international schools

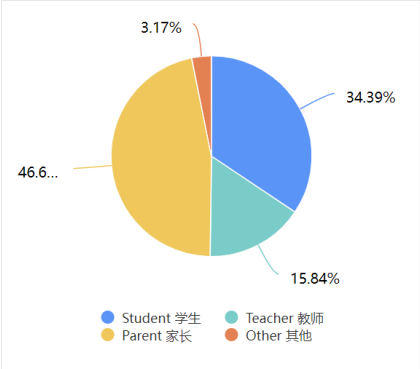


Chart 2:

Residential in the GBA, China

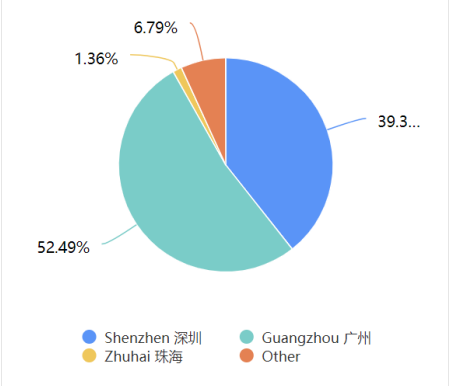


Chart 3: *Primary Language*

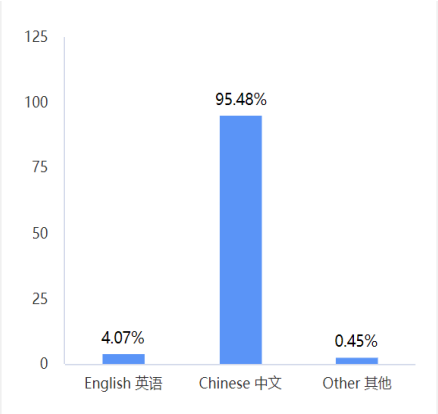


Chart 4: *How often do you use machine translation tools while learning or teaching（5 means a lot ）?*

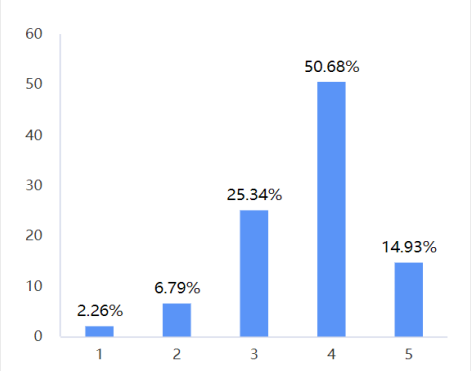


Chart 5: *How effective do you find machine translation tools in bridging the gap between the mother tongue and instructive languages (5 means extremely effective)?*

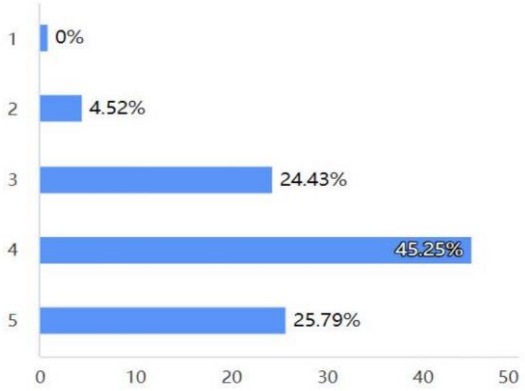


Chart 6: *Have you encountered any issues or challenges while using machine translation tools in the context of learning or teaching（ 5 means a lot ）?*

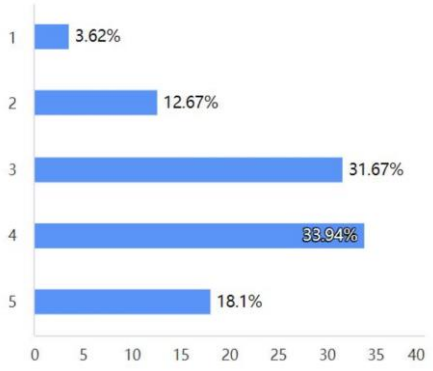


Chart 7: *How often is it used in the classroom（5 means a lot ）?*

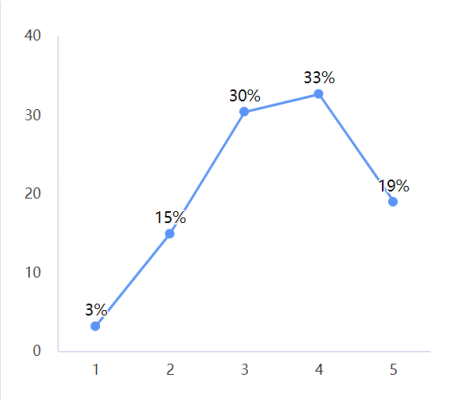


Chart 8: *How does using machine translation tools impact the classroom environment (5 means very positive)?*

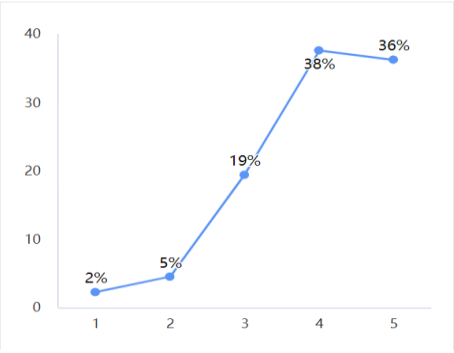


Chart 9: *How effective is ChatGPT in aiding learning or teaching（5 means very effective ）?*

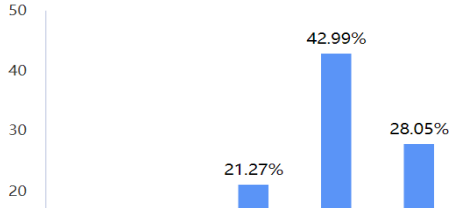


Chart 10: *How much do cultural motivations influence using machine translation tools（5 means very much ）?*

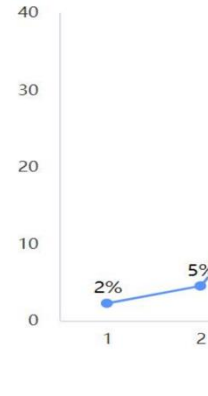


Chart 11: *How do you see the role of machine translation in learning evolving in the future（5 means very important）?*

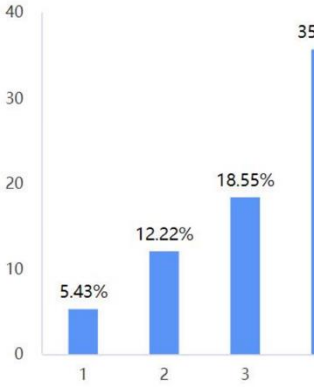
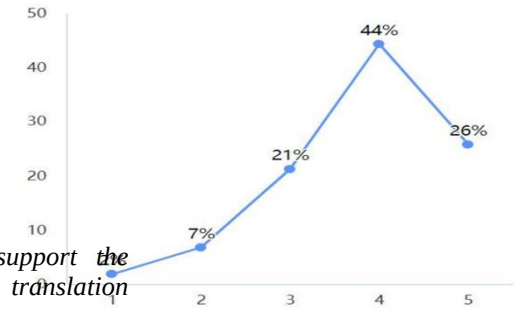


Chart 12: *Would you support the increased use of machine translation in the classroom（5 means very supportive）?*



4.1. The frequency with which machine translation is utilized in classrooms, as well as the effectiveness of its use for different stakeholders

1). The results indicate that more than half of students and teachers (50.68%) use machine translation tools when learning or teaching, suggesting that they often use machine translation. Furthermore, about 51.58% of respondents often use machine translation in the classroom, indicating a wide range of applications (Chart 4).

2). On a scale of 4 out of 5, 45.25 percent of respondents indicated that using machine translation tools is quite effective in bridging the language gap between the mother tongue and the instructional language. Approximately one in four interviewees believe that machine translation is highly effective at bridging language gaps (Chart 5).

A t-test (suppose p=0.05, see Table 1) is made to examine if there is a relationship between the frequency at which machine translation is used in classrooms and the effectiveness of machine translation.

Table 1: The Machine Translation in Classrooms Frequency and the Effectiveness

How often do you use machine translation tools in the context of learning or teaching?						
Proportion of people	Total interviewees	People who choose the scale	Scale	Scores		
2.26%	221	4.99	1	4.9946	36.20325466	
6.79%	221	15.01	2	30.0118	42.97508624	
25.34%	221	56.00	3	168.0042	26.84031123	
50.68%	221	112.00	4	448.0112	10.60434558	
14.93%	221	33.00	5	164.9765	56.4245792	
				815.9983		
			Weighted-Average	3.6923	Variance	24.33601
					Standard Deviation	4.93
How effective do you find machine translation tools in bridging the gap between the mother tongue and instructive languages?						
Proportion of people	Total interviewees	People who choose the scale	Scale	Scores		
0%	221	0	1	0	0	
4.52%	221	9.9892	2	19.9784	36.93166907	
24.43%	221	53.9903	3	161.9709	45.97597123	
45.25%	221	100.0025	4	400.01	0.5959989	
25.79%	221	56.9959	5	284.9795	66.1357534	
				866.9388		
			Weighted-Average	3.9228	Variance	30.22734
					Standard Deviation	5.4979

Group	Group 1	Group 2
Mean	3.6923	3.9228
SD	4.93	5.4979
SEM	0.331628	0.369829

Group 1:How often do you use machine translation tools in the context of learning or teaching?
Group 2:How effective do you find machine translation tools in bridging the gap between the mother tongue and instructive languages?

Null Hypothesis (H0): There is no relationship between the frequency of machine translation usage in classrooms and the effectiveness of machine translation.

Alternative Hypothesis (H1): There is a relationship between the frequency of machine translation usage in classrooms and the effectiveness of machine translation.

The two-tailed P value equals 0.6429, indicating that the difference is not statistically significant. Therefore, there is minimal relationship between the frequency of machine translation usage in classrooms and the effectiveness of machine translation. The result indicates that although machine translation has many users, its effectiveness is still an issue worthy of research.

3.) This t-test also verifies the conclusion presented in Chart 6. It is noted that there exist some challenges when using machine translation tools to learn or teach. About 52.04% of respondents to our questionnaire believe there are some or many difficulties.

4.2. How machine translation impacts the classroom and assesses how it will be developed

1). Based on our study, we discovered that most people (58.82%) believe that machine translation tools can be beneficial to education, whereas others (12.67%) believe that the use of machine translation tools can have negative implications (Chart 8). Seventy-one percent of respondents believe that AI language models such as ChatGPT will be useful in aiding the teaching or learning process (Chart 9). Lee (2019) also points out that MT can be a useful aid to

language learning, but for it to benefit student learning, teachers must be aware of its limitations and provide adequate guidance.

Vogel (2018) suggested that AI language models like ChatGPT greatly aid learning or teaching. According to our study, approximately 70.13 percent of respondents believed that machine translation tools contributed to children's learning habits in both academic and language learning. It is estimated that approximately 66.07% of respondents believe that machine translation dramatically affects children's motivation to learn new languages. In comparison, only 9.04% believe that machine translation has no or negligible influence on children's motivation to learn another language. Additionally, the study shows that the desire to engage with different cultures or the desire to become multilingual influences the use of machine translation tools in learning. 25.97% of respondents claim that machine translation greatly influences the desire to understand and engage with different cultures (Chart 10).

2). The role of machine translation in learning has become increasingly important in the era of globalization and technological development. In our survey, most respondents (73.76%) believe that machine translation will play a significant role in the future, while 63.8% support increasing the use of machine translation tools in the classroom (Charts 11 & 12).

5. Discussion and Conclusion

5.1. Discussion

5.1.1. Technology's role in young learners' academic development

Integrating machine translation (MT) in K-12 education represents a convergence of linguistic, cognitive, and technological domains. While MT has not traditionally been a focal point in K-12 educational research, the increasing globalization and digitization of education necessitate critically examining this technology's role in young learners' academic and social development. The following discussion synthesizes insights from seminal papers in machine translation, contextualizing their implications within the K-12 setting.

MT systems, especially those underpinned by neural networks and deep learning, have become remarkably sophisticated, capable of producing translations that are often indistinguishable from human-generated text (Wu et al., 2016). For K-12 students, particularly in language classes, this presents a double-edged sword. On one hand, MT can be a valuable tool for aiding comprehension and providing a safety net during the challenging phases of language acquisition (Sennrich & Birch, 2016). On the other hand, over-reliance on MT might hinder the development of intrinsic linguistic competencies, as students opt for the convenience of machine-generated translations instead of engaging in the cognitively demanding processes of language learning (Cho et al., 2014). Using MT also introduces ethical considerations that are particularly poignant for K-12 students. As young learners are still forming their moral and ethical compasses, the uncritical use of MT could lead to issues such as plagiarism and intellectual dishonesty, which is especially relevant given that advanced MT systems like Google's NMT are capable of producing seamless translations, potentially making it easier for students to pass off machine-translated work as their own (Wu et al., 2016). Moreover, the 'black box' nature of some neural MT models means that the reasoning behind translations is not always transparent, which could prevent students from engaging critically with the material (Bahdanau & Bengio, 2014). Educators must, therefore, emphasize critical thinking and digital literacy, teaching students to question and validate the information provided by digital tools.

MT can serve as a bridge between cultures, allowing students to access and understand a broader range of human experiences and perspectives (Liu et al., 2020). This aspect of MT aligns with the goals of multicultural education and the development of global citizenship

competencies. However, it is crucial to recognize that even advanced MT systems can misinterpret cultural nuances or produce biased translations, as these systems are trained on human-generated texts that may contain inherent biases (Goyal et al., 2021). Educators need to integrate discussions about cultural sensitivity and the limitations of MT in interpreting cultural contexts. For students with disabilities or those from non-native English-speaking backgrounds, MT can be an invaluable tool for accessibility (Freitag et al., 2021). In providing real-time, understandable translations of classroom materials, MT supports inclusive education by ensuring that all students can participate in the learning process, regardless of linguistic or physical barriers. However, the quality of MT can vary significantly between languages, especially for low-resource languages (Goyal et al., 2021). This variability could impact the educational experiences of students who speak these languages, potentially exacerbating educational inequalities.

The introduction of MT in the classroom also affects teacher-student dynamics. While MT can take on a supportive role, freeing educators from the minutiae of translation work and allowing them to focus on more complex pedagogical tasks, it may also lead to an over-reliance on technology, where the educator's role is undervalued (Kocmi et al., 2022). The challenge lies in finding a balance where MT complements educators' efforts without overshadowing their essential human contribution.

5.1.2. Cross-regional understanding and collaboration

Integrating machine translation (MT) in educational settings, particularly in regions like China's Greater Bay Area (GBA), presents unique opportunities and challenges. These regions are characterized by their linguistic diversity and numerous local dialects, which can pose significant barriers to communication and learning. In the GBA, rapid development has been accompanied by an increasing need for effective communication across its diverse linguistic landscape. Chen's (2022) study highlights the role of translation in mediating linguistic, economic, and cultural barriers within the GBA, particularly in education, economics, and media. This mediation is crucial in educational settings where curriculum materials must be translated into several languages to accommodate the diverse student population.

Similarly, African countries face linguistic diversity, with students often speaking different languages at home than in school (Nag et al., 2019). MT can provide real-time translation for learners and educators, facilitating access to educational materials and instruction in students' native languages. This approach can enhance understanding and retention, particularly for complex subjects.

Integrating Machine Translation and AI in K -12 education marks a significant stride toward inclusive and accessible learning. As Murphy (2019) articulates in "Artificial Intelligence Applications to Support K–12 Teachers and Teaching," the influence of AI in education has been limited compared to other sectors. However, the potential of AI, intense machine learning, could dramatically shape future classroom instruction, roles of teachers, and student learning processes. This potential is especially pronounced in the context of language learning, where tools like ChatGPT can augment traditional teaching methods, providing real-time, context-aware translation and language support, essential for regions like the Greater Bay Area with their rich linguistic diversity.

Birkun (2023), in "Using Artificial Intelligence to Develop Educational Content for Teaching Children on Cardiopulmonary Resuscitation," highlights an innovative use of AI in developing educational content. This approach can be extended to language learning, where AI can create customized learning materials, considering students' linguistic backgrounds, learning styles, and cultural contexts. Additionally, the collaborative nature of educational initiatives, as

described by Pinnell et al. (2016) in "Assessment of a Collaborative NSF RET Program Focused on Advanced Manufacturing and Materials," emphasizes the importance of immersive experiences, field trips, and real-world applications. In language learning, this could translate to virtual language exchanges, global classroom collaborations, and exposure to diverse cultures facilitated by AI and MT.

5.2. Conclusion

In conclusion, while the application of Machine Translation and AI tools like ChatGPT in K-12 education holds immense promise, it has challenges. Stakeholders must navigate issues of equity, authenticity, and privacy while leveraging these technologies' strengths (Wang et al., 2022). Factors such as differing curriculum standards, access to technology, teacher preparedness, and institutional support for digital tools can significantly influence the effectiveness and reception of AI-based solutions like ChatGPT (Leino, 2020).

In light of the transformative potential of integrating machine translation and AI tools like ChatGPT in K-12 education, particularly in linguistically diverse and transitional regions such as the Greater Bay Area, it is crucial to acknowledge the inherent research limitations that contextualize these findings and future implications. One of the primary limitations of the research is the relatively small sample size used in surveys and studies. Using surveys as a primary data collection tool introduces several potential biases and constraints. Responses may be influenced by social desirability bias, where participants respond in a manner they perceive to be favorable to researchers.

References

Anwar, T., Jimenez, A., Bin Najeeb, A., Upadhyaya, B., & McGill, M. M. (2020, August). Exploring the Enacted Computing Curriculum in K-12 Schools in South Asia: Bangladesh, Nepal, Pakistan, and Sri Lanka. In *Proceedings of the 2020 ACM Conference on International Computing Education Research* (pp. 79–90). https://doi.org/10.1145/3372782.3406251

Aydin, M. K., Gürol, M., & Vanderlinde, R. (2016). Evaluating ICT integration in Turkish K-12 schools through teachers' views. *Eurasia Journal of Mathematics Science and Technology Education*, *12*(4), 747-766. https://doi.org/10.12973/eurasia.2016.1227a

Bahdanau, D., Cho, K., & Bengio, Y. (2014). Neural machine translation by jointly learning to align and translate. https://arxiv.org/abs/1409.0473

Chen, X. (2022). Exploring the translation–development interactions from an emergent semiotic perspective: A case study of the Greater Bay Area, China. *Linguistica Antverpiensia, New Series–Themes in Translation Studies, p. 21*. https://doi.org/10.52034/lanstts.v21i.736

Cho, K., van Merrienboer, B., Gülçehre, Ç., Bahdanau, D., Bougares, F., Schwenk, H., & Bengio, Y. (2014). Learning phrase representations using RNN encoder–decoder for statistical machine translation. https://doi.org/10.3115/v1/d14-1179

Clifford, J., Merschel, L., & Munné, J. (2013). Surveying the landscape: What is the role of machine translation in language learning? revista d'innovació educativa, (10), 108-121.

Cooper, A. (2020). Justice for all: realities and possibilities of Black English learners in K–12 schools. *Teachers College Record*, *122*(13), 1–24. https://doi.org/10.1177/016146812012201311

Freitag, M., Foster, G. F., Grangier, D., Ratnakar, V., Tan, Q., & Macherey, W. (2021). Experts, errors, and context: A large-scale study of human evaluation for machine translation. https://dx.doi.org/10.1162/tacl_a_00437

Goyal, N., Gao, C., Chaudhary, V., Chen, P.-J., Wenzek, G., Ju, D., Krishnan, S., Ranzato, M., Guzmán, F., & Fan, A. (2021). The Flores-101 evaluation benchmark for low-resource and multilingual machine translation. https://dx.doi.org/10.1162/tacl_a_00474

Jolley, J. R., & Maimone, L. (2022). Thirty years of machine translation in language teaching and learning: A literature review. *L2 Journal*, *14*(1). https://doi.org/10.5070/L214151760

Klekovkina, V., & Denié-Higney, L. (2022). Machine translation: friend or foe in the language classroom? L2 Journal, 14(1). https://doi.org/10.5070/L214151723

Kocmi, T., Bawden, R., Bojar, O., Dvorkovich, A., Federmann, C., Fishel, M., Gowda, T., Graham, Y., Grundkiewicz, R., Haddow, B., Knowles, R., Koehn, P., Monz, C., Morishita, M., Nagata, M., Nakazawa, T., Novák, M., Popel, M., & Popovic, M. (2022). Findings of the 2022 Conference on Machine Translation (WMT22). https://www.aclweb.org/anthology/2022.wmt-1.1

Kumar, L., Goyal, P., Malik, K., & Kumar, R. (2020). Using machine learning, image processing & neural networks to sense bullying in K-12 schools. *Asian Journal For Convergence In Technology (AJCT) ISSN-2350-1146*, *6*(1), 14–18. https://doi.org/10.33130/AJCT.2020v06i01.004

Lai, C., Li, Z., & Gong, Y. (2019). Boundary brokering for cross-cultural professional learning in international school contexts. *British Educational Research Journal*, *45*(6), 1105-1123. https://doi.org/10.1002/berj.3553

Le Pichon, E., Naji, M., Wattar, D., & Lee, V. (2024). They are evaluating the effectiveness of digital tools for assessing young plurilingual students. In *Assessment of Plurilingual Competence and Learners in Educational Settings* (pp. 76-91). Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9781003177197-6/evaluating-effectiveness-digital-tools-assessment-young-plurilingual-students-emmanuelle-le-pichon-mai-naji-dania-wattar-vivian-lee

Leino Lindell, T. (2020). Teachers are calling for organizational support to digitalize teaching. *The international journal of information and learning technology*, *37*(5), 323-339. https://www.emerald.com/insight/content/doi/10.1108/IJILT-02-2020-0017/full/html

Liu, Y., Gu, J., Goyal, N., Li, X., Edunov, S., Ghazvininejad, M., Lewis, M., & Zettlemoyer, L. (2020). Multilingual denoising pre-training for neural machine translation. https://dx.doi.org/10.1162/tacl_a_00343

Murphy, R. F. (2019). Artificial intelligence applications to support K-12 teachers and teaching. *Rand Corporation*, *p. 10*. https://www.jstor.org/stable/pdf/resrep19907.pdf

Nag, S., Vagh, S. B., Dulay, K. M., & Snowling, M. J. (2019). Home language, school language, and children's literacy attainments: A systematic review of evidence from low- and middle-income countries. *Review of Education*, *7*(1), 91–150. https://doi.org/10.1002/rev3.3130

Powell, N., Baldwin, J., & Manning, J. (2022). Graduate STEM Student Perspectives and Implementation of Machine Translators in South Korea. *International Journal of Technology in Education and Science*, *6*(2), 237–253. https://eric.ed.gov/?id=EJ1345383

Priya, S., Bhadra, S., Chimalakonda, S., & Venigalla, A. S. M. (2022). ML-Quest: a game for introducing machine learning concepts to K-12 students. *Interactive Learning Environments*, 1-16. https://doi.org/10.1080/10494820.2022.2084115

Sennrich, R., Haddow, B., & Birch, A. (2016). Neural machine translation of rare words with subword units. https://doi.org/10.18653/v1/p16-1162

Song, J., Zhang, L., Yu, J., Peng, Y., Ma, A., & Lu, Y. (2022, June). Paving the Way for Novices: How to Teach AI for K-12 Education in China. In Proceedings of the AAAI Conference on Artificial Intelligence (Vol. 36, No. 11, pp. 12852–12857).

Tafazoli, D. (2023). Critical Appraisal of Artificial Intelligence-Mediated Communication. *arXiv preprint arXiv:2305.11897*. https://doi.org/10.48550/arXiv.2305.11897

Urlaub, P., & Dessein, E. (2022). Machine translation and foreign language education. *Frontiers in Artificial Intelligence*, *5*, 936111. https://doi.org/10.3389/frai.2022.936111

Vogel, S., Ascenzi-Moreno, L., & García, O. (2018). An expanded view of translanguaging: Leveraging the dynamic interactions between a young multilingual writer and machine translation software.

Sangmin-Michelle Lee (2020). The impact of using machine translation on EFL students' writing, Computer Assisted Language Learning, 33:3, 157–175, DOI: 10.1080/09588221.2018.1553186.

Wang, Y., Su, Z., Zhang, N., Xing, R., Liu, D., Luan, T. H., & Shen, X. (2022). A survey on metaverse: Fundamentals, security, and privacy. *IEEE Communications Surveys & Tutorials*. Doi: 10.1109/COMST.2022.3202047.

Wu, Y., Schuster, M., Chen, Z., Le, Q. V., Norouzi, M., Macherey, W., ... & Dean, J. (2016). Google's neural machine translation system: Bridging the gap between human and machine translation. *arXiv preprint arXiv:1609.08144*. https://doi.org/10.48550/arXiv.1609.08144

Zhang, J., Gao, X., Chen, H., Chen, L., Wang, L., Luo, J. D., & Fu, X. (2021, July). A data-driven analysis of k-12 students' participation and learning performance on an online supplementary learning platform. In 2021 International Conference on Computer Communications and Networks (ICCCN) (pp. 1–9). IEEE. Doi: 10.1109/ICCCN52240.2021.9522295.