The Effect of AI-Powered Technologies on the Motivation to Learn Foreign Languages: A State-of-the-Art Review and Meta-Analysis

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Abstract: This paper reviews current research and provides a meta-analysis on how AI technologies, specifically Automatic Speech Recognition (ASR), Text-to-Speech (TTS), Machine Translation (MT), and Generative AI (GenAI), affect motivation in Second Language Acquisition (SLA). Learning a new language is a demanding task that requires ongoing motivation and significant effort. Modern AI tools offer new possibilities for supporting language learners and potentially making the learning process easier and more engaging. However, these same technologies may also reduce motivation by allowing learners to avoid challenging language tasks by relying heavily on technological support. By examining 35 peer-reviewed studies, this review finds that most (66%) report a positive impact of AI tools on learner motivation. Practical evidence suggests these technologies can significantly boost motivation, engagement, and language proficiency, especially under controlled experimental settings. However, concerns remain about learners becoming too dependent on technology, potentially lowering their internal motivation to truly "learn" a language. The paper recommends that teachers actively guide students in using AI tools effectively to ensure meaningful language learning and to maintain genuine motivation. It concludes that integrating AI tools into language education requires careful balance, recognizing their benefits while avoiding excessive reliance and superficial engagement.

Keywords: Automatic Speech Recognition (ASR), Text-to-Speech (TTS), Machine Translation (MT), Generative AI (GenAI), Second Language Acquisition (SLA)

INTRODUCTION

Anyone who has ever tried to learn a foreign language knows that it is an incredibly difficult and challenging process, requiring determination, commitment, and grit. It also requires a lot of time, with the US Department of State estimating between 600 and 2200 total hours of intentional study for a native English speaker to become competent in a foreign language, with longer times required for languages that are linguistically or culturally distant from English (US Department of State, 2023). Given the difficulty of learning foreign languages, it is inevitable that without a strong source of motivation, many potential language learners will struggle and ultimately fail.

A multitude of technologies have been developed that can enhance or assist the learning of languages. In fact, language learners in the 21st century have a vast range of technological affordances available to them, including websites, smartphone apps, YouTube channels, online lessons, and powerful mobile devices that allow them to connect and communicate with foreign language speakers more easily and conveniently than at any other time in history.

In addition, in recent years, technologies powered by or leveraging Artificial Intelligence (AI) have been developing at a breakneck pace. Such technologies include Automatic Speech Recognition (ASR), Text-to-Speech (TTS), Machine Translation (MT), and Generative AI (GenAI). However, while these AI technologies have the potential to assist or enhance the foreign language learning process by providing unprecedented interactive access to both spoken and written foreign language models, they also offer the possibility to avoid or negate the language learning process altogether by delegating the cognitively demanding task of understanding and producing a foreign language to AI (Lewis-Kraus, 2016; Siemens et al., 2022).

In formal language learning contexts, such as schools and universities, learners may become tempted to utilize GenAI tools such as ChatGPT to complete their homework assignments for them (Raine, 2023). Alternatively, they might be tempted to compose written assignments in their native language and then have an MT tool such as DeepL automatically translate it into the language they are supposed to be learning (Kavanagh, 2023). If the student fails to cognitively engage further with the written output of these tools, it would be difficult to say that any "learning" is taking place. Meanwhile, in informal foreign language use contexts, simultaneous translation technologies such as Google Assistant's "interpreter mode" (Google, 2023) or the Timekettle WT2 Edge Translator Earbuds (https://www.timekettle.co) might be used to facilitate conversation between two speakers of different languages without either of them having to learn the other's language (Pluymaekers, 2022). Given the unique capacity for AI to perform cognitive tasks formerly considered to be within the human domain of competence (Siemens et al., 2022), it is logical to treat tools such as ASR, TTS, MT, and GenAI as substantively different from the technologies that preceded them. For the first time in history, it is theoretically possible to delegate the comprehension and production of foreign languages to a combination of one or more AI-powered tools.

How will humans respond when machines are able to do in a fraction of the time cognitive tasks that take humans thousands of hours of study to master? Will it have a positive or negative effect on their motivation to learn to do these tasks themselves? This report presents a State-of-the-Art review of AI technologies and a meta-analysis of the nexus between these technologies and the motivation to learn foreign languages. It achieves this by "collecting, describing, analyzing, and integrating" information (Barry, Merkebu & Varpio, 2022) gleaned from the substantive body of scholarly knowledge available to researchers online. In doing so, this report aims to address the following question: *What effect do AI-powered technologies have on the motivation to learn foreign languages?*

LITERATURE REVIEW

AI-powered technologies

Since there is no commonly accepted definition of the term "Artificial Intelligence" (AI) (Sheikh, Prins & Schrijvers, 2023), it is crucial to specify how that term is being used in this report. In recent years, AI has become synonymous with Machine Learning (ML), meaning computer programs that have been learned from large amounts of data rather than relying solely on procedural routines written by humans (Alpaydin, 2021). Although some of the technologies mentioned in this report did not historically rely on AI or ML, the latest and most powerful iterations of them invariably do. For that reason, when the term "AI" is used in this report, it is used to refer to technologies that approach, equal, or surpass human intelligence in narrow domains by leveraging ML.

This report will specifically address four types of AI-powered technologies that have special relevance to language learners: Automatic Speech Recognition, Text-to-Speech, Machine Translation, and Generative AI. The development of each of these technologies is discussed below.

Automatic Speech Recognition (ASR)

Automatic Speech Recognition (ASR), also known as "Speech-To-Text" (STT), is a way of using computer technology to automatically recognize human speech and transcribe it into a written form. Attempts to develop mechanical systems that could recognize human speech started in earnest in the late 1950s. One of the earliest mentions on Google Scholar of "speech recognition" in relation to a machine that can recognize speech is a paper published by D. L. Shultz in 1957. In the abstract, the author notes that a theoretical speech recognition machine:

"…must be familiar with the language statistics, and indeed, the entire human environment. Many years of investigation will be required before such a human replacement can be achieved." (Shultz, 1957)

The paper goes on to describe a system that can categorize speech sounds but falls short of recognizing entire words and sentences. Almost two decades later, in 1976, D. R. Reddy provides a review of recent developments in speech recognition and notes that:

"…we are very far from being able to handle relatively unrestricted dialogues from a large population of speakers in uncontrolled environments" (Reddy, 1976).

In the 1990s and early 2000s, the focus shifted towards developing more sophisticated algorithms and statistical models, particularly with the use of Hidden Markov Models (HMMs), which enhanced the ability of ASR systems to deal with natural language variations (Juang & Rabiner, 1991). The introduction of Machine Learning and, subsequently, Deep Learning techniques in the 2010s marked a significant leap in performance, enabling ASR systems to achieve near-human levels of accuracy (Deng, Hinton & Kingsbury, 2013). The 2020s saw the development of advanced systems like OpenAI's Whisper and Google's Cloud Speech-To-Text, which can handle diverse dialects, accents, and noisy environments, showcasing the remarkable progress made in ASR technology over the years.

Text-to-Speech (TTS)

Text-to-Speech (TTS), also known as "speech synthesis," is a way of artificially producing human-like speech with computer technology. The very earliest mentions of "speech synthesis" in Google Scholar date back to the late 1930s, with a paper written by Bell Telephone Laboratories engineer Homer Dudley (1939) describing a human-operated organ-like machine called the "Voder" that "fashions its synthetic speech out of two basic sound streams" (Dudley, 1939, p. 378).

Following Dudley's work, Text-to-Speech (TTS) technology advanced significantly over the next several decades. The shift from mechanical to electronic and digital methods became more pronounced in the 1950s and 1960s with the advent of computer-based speech synthesis (Klatt, 1987). The 1970s and 1980s saw further enhancements with digital signal processing, leading to more natural-sounding speech. This progress paved the way for the integration of Machine Learning techniques, especially in the late 1990s and 2000s (e.g., Bakiri & Dietterich, 1999). These advancements, including the use of Hidden Markov Models, laid the groundwork for the deep learning revolution in TTS technology in the 21st century (Kayte, Mundada & Gujrathi, 2015). This process has culminated in highly realistic and expressive forms of synthetic speech, such as ElevenLabs' speech synthesis platform.

Machine Translation (MT)

Machine Translation (MT) is a way of using computer technology to automatically translate text in one language to text with an equivalent meaning in another language. Cutting-edge MT such as Google's AudioPaLM system can also perform speech-to-speech translation (S2ST), but this report will focus only on text-to-text translation, as S2ST technologies are still in their infancy. The first mentions of MT in the literature date back to the early 1950s. A seminal memorandum on the possibility of MT was written by Warren Weaver in 1952. In it, he ponders whether "…the problem of translation could conceivably be treated as a problem in cryptography." (Weaver, 1952, p. 4). While he could not see any promising actual solutions to the problems of dealing with "multiple meaning, context, [and] word order" (Weaver, 1952, p. 7), he nevertheless theorized that techniques could be developed to make even rudimentary forms of MT "worthwhile" (Weaver, 1952, p. 4).

The earliest attempts at MT did not leverage AI and instead employed rather complex systems of procedural rules for translating various language pairs. In the early 1960s, Halliday described MT as a problem of Applied Linguistics and stated that successful MT would require "not only the descriptions of two languages, but also the rules for the systematic relating of these two descriptions one to the other." (Halliday, 1962, p.147). Some researchers (e.g., Nagao et al., 1980) attempted to build "rule based" MT programs, but this approach had limited success and was superseded first by Statistical Machine Translation (SMT) in the early 1990s and then by Neural Machine Translation (NMT) in the mid-2010s (Och & Ney, 2000; Stahlberg, 2020).

SMT was "grounded in the premise that language is so rich and complex that it could never be fully analyzed and distilled into a set of rules" (Koehn, 2009) marking a sharp departure from the ideas of Halliday (1962) and Nagao et al. (1980). Instead, SMT worked by analyzing large bilingual text corpora to develop statistical models, identifying how words and phrases are translated between languages. It involved aligning text segments in both languages creating language and translation models to predict sentence structures and translations. The process used these models to decode and generate translations, refining its accuracy over time with more data.

In the mid-2010s, however, SMT was in turn superseded by Neural Machine Translation (NMT). NMT uses a single neural network to translate languages, making it more streamlined than SMT. Its key feature, the "attention mechanism," allows the model to focus on relevant parts of the source text for more accurate translations. Advanced NMT models improve this process further, understanding complex sentence structures and maintaining word order effectively. Overall, NMT offers more fluent and context-aware translations compared to SMT (Stahlberg, 2020). Today, the most reliable and accurate MT services, such as DeepL and Google Translate rely on advanced NMT technologies to provide fluent and contextually accurate translations.

Generative AI (GenAI)

The term "generative AI" (GenAI) refers to a class of technologies that generate original content, such as text, audio, or images, based on user input commonly known as "prompts." GenAI has gained a lot of attention in the media in the last few years, especially technologies developed and released by OpenAI. OpenAI is the California-based company behind ChatGPT, a seminal GenAI application released to the public in November 2022, known for its ability to create incredibly human-like texts while allowing for the user to interact with it in a natural conversational manner (Ray, 2023).

GenAI is the most recent of the AI technologies discussed in this paper and was not widely mentioned or discussed in academic literature until the early 2020s, but the academic and public interest in GenAI since the release of ChatGPT cannot be overstated. To illustrate this fact, a Google Scholar search for "Generative AI" that restricts results by date to papers published before 2023 generates only 1430 hits, many of which are irrelevant. But a search for "Generative AI," which restricts the publication date to just the year 2023, generates 19,500 hits. This suggests that the release of ChatGPT in late 2022 heralded a sea change in AI and its implications for society and culture.

While GenAI is more than just ChatGPT, ChatGPT is like the iPhone of smartphones; it pushed a new technology thoroughly into the public eye and forced other Big Tech companies to catch up, with Microsoft releasing Bing Chat (now Microsoft Copilot) in February 2023 and Google releasing Bard (now Gemini) in March 2023. Microsoft has also heavily invested in OpenAI (Metz & Weise, 2023) and is the de facto owner of the Large Language Model (LLM) that ChatGPT is based on (Hao, 2020).

THEORETICAL FRAMEWORKS

In this section, I will introduce and discuss pertinent theoretical frameworks for the current study, specifically in relation to two crucial questions: what it means to learn a foreign language and why people are motivated to learn foreign languages.

What it means to "learn" a foreign language

The two most common acronyms for describing the use of technology in language education, Computer Assisted Language Learning (CALL) and Technology Enhanced Language Learning (TELL), both include the word "learn." But what do we mean by "learn"? What does it mean to "learn" something and is learning a language different in important ways from learning other things?

A common sense understanding of what it means to "learn" something might go something like this: you have "learned" a thing if you are able to recall, perform, or produce that thing in a variety of situations independently and without assistance. Of course, there is more to learning than simple memorization, recall, and performance or production. Understanding is also necessary, otherwise, the thing that has been "learned" has arguably not been "learned" at all and is only being "parroted" at a very superficial level. Bloom's Taxonomy of learning, first published in 1956,, suggests there are several facets of "learning" (Bloom et al., 1956): knowledge, comprehension, application, analysis, synthesis, and evaluation. Bloom's Taxonomy was revised in 2001, and the different facets of learning were restated as cognitive abilities, namely the ability to remember, understand, apply, analyze, evaluate, and ultimately create information and knowledge (Anderson & Krathwohl, 2001). Bloom's Taxonomy has also been more recently revisited in the light of AI. The revised Taxonomy, published as guidance for academic faculty at Oregon State University, seeks to distinguish AI capabilities from skills that are distinctively human in nature (Oregon State University, 2023).

Language is unique because it is not just a subject of learning but also the means by which we learn. The ability to use a foreign language involves a wide range of cognitive faculties, as well as the complex interplay between the four skills of listening, speaking, reading, and writing. It also involves the interrelated aspects of competence and performance, with competence being the knowledge or understanding of language in the mind and performance the ability to use the language in real-world situations (Chomsky, 1965). To complicate things further, some academics have argued that foreign languages are not "learned" at all but only "acquired," which is a cognitive process quite distinct from "learning." This theory states that while learning is a conscious process, acquisition is unconscious and happens automatically and naturally when we are exposed to comprehensible forms of the target language (Krashen, 1981; 1994).

Another way to understand what it means to "learn" a foreign language is through the Common European Framework of Reference for Languages (CEFR), first published by the European Council in 2001 and significantly updated in 2020 (Council of Europe, 2001; 2020a). The CEFR emphasizes what language learners can do independently with the target language in real-life situations. The CEFR categorizes language learners into 6 levels (A1, A2, B1, B2, C1, and C2) and provides descriptors for what language learners should be able to do with the target language at each level. These descriptors are also known as "can-do" statements; for example, at the A1 level, learners should be able to "communicate basic information about personal details and needs of a concrete type in a simple way" (Council of Europe, 2020b), whereas at the C2 level, they should be able to "convey finer shades of meaning precisely by using, with reasonable accuracy, a wide range of qualifying devices" (Council of Europe, 2020b). The crucial point for the current paper is that whatever language learners "can do," they can do *independently* and *in real-life situations*.

Finally, we should consider how the meaning of "language learning" has been influenced by language assessment. When assessing language proficiency in formal educational contexts, language learners are typically placed into controlled test conditions and forbidden from relying on their teacher, technology, or their peers for assistance. Three of the most commonly used instruments for assessing English language proficiency are the Test of English for International Communication (TOEIC), the Test of English as a Foreign Language (TOEFL), and the International English Language Testing System (IELTS). Official guidance for all three tests explicitly forbids the use of any kind of technology during the test or receiving any kind of assistance from either other test takers or the proctor (Educational Testing Service 2023a; Educational Testing Service 2023b; IELTS 2023). This state of affairs hammers home the idea that "learning" a foreign language means being able to use and understand it *independently* and *without assistance*.

Motivation to learn foreign languages

In this section of the report, frameworks for motivation to learn foreign languages are discussed. The preeminent authority on motivation in Second Language Acquisition (SLA) was the late Dr. Zoltán Dörnyei, a psychologist and applied linguist known for his theories on motivation and foreign language learning. Dörnyei reiterates the point made at the beginning of this paper, that foreign language learning is a "long and often tedious… process" (Dörnyei, 1998, p.117). He also points out that far from there being a lack of theories on motivation. There is actually an excess, resulting in a situation that can confound rather than clarify our understanding of motivation. Of the various theories and frameworks discussed in his paper, the "expectancy-value" theory is one of the most pertinent for current purposes. Dörnyei explains the expectancy-value theory of motivation as follows:

"…motivation to perform various tasks is the product of two key factors: the individual's expectancy of success in a given task and the value the individual attaches to success in that task. The greater the perceived likelihood of goal-attainment and the greater the incentive value of the goal, the higher the degree of the individual's positive motivation." (Dörnyei, 1998, p. 119).

Reflecting on the essence of "learning" a foreign language, the expectancy-value theory of motivation illuminates a crucial aspect: learners must not only believe in their capacity to independently use and comprehend the language in various situations but also recognize significant value in this ability. While the introduction of AI-powered technologies can bolster the expectancy aspect by potentially easing the language learning process, these advancements also present a conundrum. They may diminish the perceived value of learning a foreign language, as technology offers alternative means of communication without the necessity of language acquisition.

As a general theory of motivation, expectancy-value is very powerful, but it's not the whole story when it comes to the motivation to learn a foreign language. Because learning a foreign language is essentially a social activity, we must also bear in mind the learner's disposition toward the speech community of the target language. This idea is associated with the work of Robert Gardner, who developed the concept of "integrative motivation" and contrasted it with "instrumental motivation." Integrative motivation refers to the desire to learn a second language due to a genuine interest in the language and culture, along with a wish to integrate or become closer to the community of the target language. This contrasts with instrumental motivation, which is driven by practical reasons such as job opportunities or academic requirements (Gardner, 1985). We can also think of the integrative-instrumental dichotomy in terms of intrinsic versus extrinsic motivation, where integrative motivation aligns with intrinsic factors, driven by a genuine

interest in the language and culture for personal fulfillment, and instrumental motivation correlates with extrinsic factors, motivated by external rewards such as career advancement or academic achievement.

In a more recent paper, Matsuzaki Carreira points out that motivation in SLA contexts is often not as simple as the integrative-instrumental or intrinsic-extrinsic dichotomy and is in fact a "multifaceted phenomenon" (Matsuzaki Carreira, 2005, p.42). She points out that some learners may only be studying foreign languages because they will feel guilty if they don't ("introjected regulation") or indeed because it is a required or compulsory class in formal educational contexts (Matsuzaki Carreira, 2005, p.44). When it comes to compulsory foreign language classes, such as English language classes in Japan, what may be required is an analysis and understanding of the motivation of policymakers rather than language learners themselves. In some compulsory education contexts, all the students know is that they have to learn a foreign language to pass their current classes and to progress to the next year of their education.

RESEARCH DESIGN & METHODS

In the second part of this paper, I will present a meta-analysis of the literature on the nexus between AI technologies such as ASR, TTS, MT, and GenAI and the motivation to learn foreign languages. In particular, I am looking to discover whether AI technologies have had a positive or negative effect on any kind of motivation to learn a foreign language, where "learn" means to be able to use and understand the language in a variety of situations independently and without assistance.

The meta-analysis for this paper was conducted by aggregating and analyzing literature from a body of academic knowledge made accessible via the Google Scholar search portal. To ensure comprehensive coverage of the different AI technologies of interest in this paper, 5 searches of the Google Scholar database were made, one for each of the following queries:

1. "artificial intelligence language learning motivation"
2. "automatic speech recognition language learning motivation"
3. "text to speech language learning motivation"
4. "machine translation language learning motivation"
5. "generative ai language learning motivation"

In order to improve the quality, efficiency, and replicability of this analysis, only open-access peer-reviewed journal articles were included, and in the interest of time and space constraints, only the first five pages of results for each query were considered. The results were sorted according to Google Scholar's algorithm for "relevance." Any papers not explicitly referring to the motivation to learn foreign languages were excluded, for example, papers focusing on the motivation to learn subjects other than foreign languages or papers focusing on the motivation to develop AI technologies. This search method yielded 35 papers of relevance, as detailed below.

RESULTS

Of the 35 papers reviewed for this meta-analysis, 9 focused on ASR, 6 on GenAI, 6 on MT, 2 on TTS, and the remaining 12 on various combinations of these technologies. 24 of the papers were of an empirical nature, meaning that the authors had conducted primary research of some kind, such as surveys or experiments. In 9 of the papers, no primary research had been conducted by the authors, but the authors had conducted meta-analyses or literature reviews of existing studies. The remaining two papers consisted of one report of a debate and one report of the development of a piece of software. The papers' publication dates ranged over 20 years, from 2003 to 2023, with 20 of the papers being published after 2020, which indicates the contemporary nature of the research in this area.

It is useful to further sub-categorize the 24 empirical papers by the type of empirical research that was undertaken. In 15 of these papers (62.5%), the authors conducted experiments where the participants were exposed to AI-powered treatments and language learning gains were objectively measured. In the other 9 papers (37.5%), the authors had opted to administer surveys or conduct interviews but did not objectively measure language learning gains. Further details of the analyzed papers can be found in Table 1, below.

Table 1. List of papers reviewed for the meta-analysis and key findings of each paper.

Journal Name, Paper Title & Date of Publication	Paper Type	First Author	Area of AI	Effect	Key Findings
CALICO Journal Recent Developments in Technology and Language Learning: A Literature Review and Meta-analysis (2003)	Meta Analysis / Literature Review	Zhao	Various	Positive	The study provides a literature review and meta-analysis on technology in language education, focusing on multimedia and speech technologies. It reveals positive effects on language learning, suggesting an indirectly positive impact on learning motivation.
Journal of Educational Technology & Society Automatic Speech Recognition: Reliability and Pedagogical Implications for Teaching Pronunciation (2006)	Empirical (experimental)	Kim	ASR	Nuanced	The study evaluates the use of ASR software in teaching English pronunciation, focusing on its reliability compared to human raters. Despite a weak correlation with human ratings, the authors remain optimistic about ASR's effectiveness as a teaching aid in pronunciation, suggesting a nuanced impact on students' motivation.
Computer Assisted Language Learning A Study of web-based oral activities enhanced by Automatic Speech Recognition for EFL college learning (2007)	Empirical (experimental / survey)	Chiu	ASR	Positive	Assesses CandleTalk, an ASR-enhanced web-based tool, for teaching English speech acts. Shows improved ability in speech act performance, especially for lower proficiency students, but not in speech comprehensibility. Indicates a positive impact on motivation and speech act usage ability.
Computer Animation and Virtual Worlds Language learning with interactive virtual agent scenarios and speech recognition: Lessons learned (2008)	Software Description	Anderson	Various	Positive	Investigates a system integrating speech recognition with virtual scenarios for language learning, noting enhanced student engagement and motivation. Despite issues with speech recognition accuracy, the system effectively motivates learners.

Table 1 (continued).

ReCALL Machine translation in foreign language learning: language learners' and tutors' perceptions of its advantages and disadvantages (2009)	Empirical (survey)	Niño	MT	Nuanced	The study on machine translation in language learning found its effectiveness varies by user proficiency and task complexity. MT is beneficial for vocabulary and comprehension but presents challenges, leading to a nuanced impact on motivation.
ReCALL On the effectiveness of Robot-Assisted Language Learning (2011)	Empirical (experimental / survey)	Lee	Various	Positive	The study examined robot-assisted language learning (RALL) on elementary students' English skills. It found significant improvements in speaking skills and positive influences on students' satisfaction, interest, confidence, and motivation in learning English.
Computer Assisted Language Learning Technologies for foreign language learning: a review of technology types and their effectiveness (2014)	Meta Analysis / Literature Review	Golonka	Various	Positive	Reviews various technologies in foreign language learning, noting limited concrete evidence of their efficacy but strong support for certain tools like ASR and chat. Suggests these technologies can positively influence learning outcomes, including motivation and interaction.
JALT CALL Journal Automatic speech recognition technology as an effective means for teaching pronunciation (2014)	Empirical (experimental)	Eliminate	ASR	Positive	The study examines the effectiveness of ASR in teaching English pronunciation to third-grade students, comparing it with regular instruction methods. It shows that the ASR method significantly improved students' pronunciation performance, indicating a positive impact on learning motivation.

Table 1 (continued).

British Journal of Educational Technology User experience of a mobile speaking application with automatic speech recognition for EFL learning (2016)	Empirical (survey)	Ahn	ASR	Positive	Study on ASR in mobile apps for English learning among Korean students. Positive effect on motivation, appreciated for interactivity and feedback. Lacks assessment of actual speaking skill improvement.
Computer Assisted Language Learning Evaluating automatic speech recognition-based language learning systems: a case study (2016)	Empirical (survey)	Van Doremalen	ASR	Positive	The study evaluates an ASR-based language learning system, finding it beneficial for improving speaking skills in Dutch. Users appreciated its potential for pronunciation practice, positively influencing motivation and learning effectiveness.
Journal of Spanish Language Teaching The role of translation technologies in Spanish language learning (2017)	Meta Analysis / Literature Review	Jiménez-Crespo	MT	Positive	Reviews translation technologies in Spanish language education, highlighting benefits in language acquisition and reading and writing skills enhancement. Positively assesses the impact on motivation, considering these technologies' educational advantages.
Foreign Language Annals Seeing how people hear you: French learners experiencing intelligibility through automatic speech recognition (2018)	Empirical (experimental / survey)	Mroz	ASR	Nuanced	The study on Gmail's ASR for French learning showed it improved motivation, self-confidence, and willingness to communicate. ASR was perceived to be a credible substitute for a native human interlocutor. Proficiency gains were shown for about half the participants.
Foreign Language Annals Machine translation and the L2 classroom: Pedagogical solutions for making peace with Google translate (2018)	Meta Analysis / Literature Review	Ducar	MT	Nuanced	Analyzes Google Translate in language education, discussing its capabilities and limitations. Emphasizes the need for responsible use in classrooms to support language skills development and uphold academic integrity. The study implies a nuanced impact on language learning motivation.

Table 1 (continued).

Journal of Tourism Studies Use and Effects of an Online Text-to-Speech Resource to Improve English Listening for the TOEIC Test (2019)	Empirical (experimental / survey)	Nakai	TTS	Positive	The study analyzed the use of online Text-to-Speech resources for improving English listening skills for the TOEIC test. It found that these resources helped students feel less anxious and more confident in understanding and learning English. The study suggests a positive impact on students' motivation to learn English, particularly among those with lower proficiency levels.
The New Educational Review Adapting an Anthropomorphized Robot for Enhancing EFL Learning Motivation and Performance at an Elementary School in Taiwan (2019)	Empirical (experimental)	Tsai	Various	Positive	Robot-assisted English learning study: Improved students' English skills and learning motivation, indicating a positive impact from robotic assistance in language education.
Computer Assisted Language Learning The impact of using machine translation on EFL students' writing (2020)	Empirical (experimental / survey)	Lee	MT	Nuanced	The study explores the use of machine translation (MT) in EFL writing. It finds that MT positively influences student writing by reducing errors and enhancing revision strategies. However, it also notes limitations in MT's accuracy and its influence on student writing style, suggesting a nuanced impact on learning motivation.
International Journal of Internet, Broadcasting and Communication Learner-Generated Digital Listening Materials Using Text-to-Speech for Self-Directed Listening Practice (2020)	Empirical (survey)	Moon	TTS	Positive	The study focused on self-generated digital listening materials using Text-to-Speech (TTS) for English language learning. It found that learners experienced reduced anxiety, enhanced confidence, and increased motivation in language learning. The use of TTS for creating personalized listening materials showed a positive effect on improving listening skills and overall language proficiency.

Table 1 (continued).

Journal of Language and Social Psychology The Identity Crisis in Language Motivation Research (2021)	Meta Analysis / Literature Review	Al-Hoorie	Various	Nuanced	Suggests a shift to tangible constructs like engagement, promoting transdisciplinary research. Highlights AI's potential in revolutionizing personalized language learning methods.
Korean Journal of Applied Linguistics The Effect of Real-time Score Feedback on L2 English Learners' Pronunciation and Motivation in an ASR-based CAPT System (2021)	Empirical (experimental / survey)	Randall	ASR	Positive	ASR-based CAPT system study: Found improved pronunciation and motivation in L2 English learners, with positive perceptions of the system's usefulness.
Computer Assisted Language Learning Types, purposes, and effectiveness of state-of-the-art technologies for second and foreign language learning (2022)	Meta Analysis / Literature Review	Zhang	Various	Positive	The study analyzes advanced technologies in language learning (2016-2019) like mobile, multimedia, and speech recognition. These technologies positively impact language learning motivation and instructional methods.
Computer Assisted Language Learning Web-based language learning and speaking anxiety (2022)	Empirical (survey / interview)	Bashori	ASR	Positive	Investigates the effect of web-based language learning with ASR on speaking anxiety among Indonesian vocational high school students. The study reveals that web-based learning tools, particularly with ASR, can reduce speaking anxiety, indicating a positive influence on learners' motivation.
Interactive Learning Environments Examining the roles of social presence and human-likeness on Iranian EFL learners' motivation using artificial intelligence technology: a case of CSIEC chatbot (2022)	Empirical (experimental / survey)	Ebadi	Various	Positive	The study explores the effect of the CSIEC chatbot on Iranian EFL learners' motivation, focusing on social presence and human-likeness. It finds that these aspects of the AI chatbot significantly enhance learner motivation.

Table 1 (continued).

Computer Assisted Language Learning Mobile-assisted pronunciation learning with feedback from peers and/or automatic speech recognition: a mixed-methods study (2023)	Empirical (experimental / survey)	Dai	ASR	Nuanced	The study investigates the impact of mobile-assisted pronunciation learning using peer and/or ASR feedback. It shows that while all methods improved pronunciation, peer plus ASR feedback and peer feedback alone were both more effective than ASR alone. The findings suggest a nuanced effect of ASR on motivation for pronunciation learning.
Edumaspul: Jurnal Pendidikan Artificial Intelligence and English Classroom: The Implications of AI Toward EFL Students' Motivation (2023)	Empirical (survey)	Moybeka	Various	Nuanced	The study investigated AI's impact on EFL students' motivation. It found AI enhances intrinsic motivation, boosts self-efficacy, and facilitates personalized learning experiences. However, it also acknowledged challenges like overreliance on AI, which might reduce intrinsic motivation, and concerns about data privacy and algorithmic bias. Overall, the impact on learning motivation is nuanced, requiring a balanced approach integrating AI and human-led instruction.
Indonesian Journal of English Language Teaching and Applied Linguistics Exploring the Implications of ChatGPT for Language Learning in Higher Education (2023)	Meta Analysis / Literature Review	Baskara	GenAI	Positive	Examines ChatGPT's role in enhancing language learning in higher education, focusing on personalized instruction and generating authentic language materials. Discusses ethical and social considerations and potential limitations, suggesting a positive impact on language learning motivation.
Interactive Learning Environments Teacher support and student motivation to learn with Artificial Intelligence (AI) based chatbot (2023)	Empirical (experimental / survey)	Chiu	Various	Positive	Examines teacher support and student expertise in AI chatbot learning, focusing on motivation. Reveals a nuanced relationship between these factors and motivation, with a positive overall impact.

Table 1 (continued).

International Journal of Education in Mathematics, Science, and Technology The Effect of Using Artificial Intelligence and Digital Learning Tools based on Project-Based Learning Approach in Foreign Language Teaching on Students' Success and Motivation (2023)	Empirical (experimental)	Azamatova	Various	Positive	Examines digital tools and AI applications in Russian language courses using a project-based learning approach. Finds significant positive effects on students' academic achievement, motivation, and learning retention compared to traditional teaching methods. Suggests digital tools and AI enhance foreign language learning quality and efficiency.
International Journal of New Developments in Education Revolutionizing ESL Teaching with Generative Artificial Intelligence—Take ChatGPT as an Example (2023)	Meta Analysis / Literature Review	Liao	GenAI	Positive	The study found that generative AI like ChatGPT helps in ESL learning but has challenges. AI sometimes produces less natural, more rigid language and requires significant user interaction, impacting learning motivation positively but with certain complexities.
Journal for ReAttach Therapy and Developmental Diversities Exploring the Psychological Impact of Machine Translation on Improving English Vocabulary Proficiency among University Students (2023)	Meta Analysis / Literature Review	Purnama	MT	Nuanced	The study on Machine Translation for English vocabulary learning found it beneficial but with challenges. MT, especially Google Translate, improves understanding but needs careful use due to inaccuracies. The impact on motivation is positively nuanced.
Journal of English Studies in Arabia Felix Impact of ChatGPT on Learning Motivation: Teachers' and Students' Voices (2023)	Empirical (survey)	Ali	GenAI	Nuanced	The study examines ChatGPT's influence on English learning motivation, showing increased motivation for reading and writing but a neutral impact on listening and speaking skills. Highlights the need for more detailed research on this aspect.

Table 1 (continued).

Journal of Namibian Studies The Potentials Of Artificial Intelligence In Stimulating Motivation And Improving Performance Of Undergraduates In Foreign Languages (2023)	Empirical (survey)	Khasawneh	Various	Positive	Investigates AI's impact on foreign language learning motivation and performance among undergraduates. Finds significant enhancement in both motivation and academic performance due to AI integration.
Journal of Teacher Education and Lifelong Learning The impact of ChatGPT on language learners' motivation (2023)	Empirical (experimental / survey)	Yıldız	GenAI	Positive	The study investigates the impact of ChatGPT on vocabulary learning and motivation among language learners. It found that integrating ChatGPT into post-lesson activities positively affects motivation, particularly in self-regulation, intrinsic value, and test anxiety. The results indicate that using ChatGPT in language learning environments enhances students' academic performance and motivation.
Language Assessment Quarterly The Use of Assistive Technologies Including Generative AI by Test Takers in Language Assessment: A Debate of Theory and Practice (2023)	Debate	Voss	GenAI	Nuanced	The paper discusses the impact of generative AI on language assessment and learning, emphasizing validity, fairness, and bias concerns. It indirectly addresses learning motivation but focuses more on assessment implications.
Language Learning & Technology Student use and instructor beliefs: Machine translation in language education (2023)	Empirical (experimental / survey)	Hellmich	MT	Nuanced	Analyzes machine translation use in language learning, revealing a complex dynamic between student usage and instructor perceptions. Highlights the strategic use of MT by students, suggesting a multifaceted effect on motivation. Advocates for informed and critical integration of MT in language education.

Table 1 (continued).

Library Hi Tech Exploring the dimensions of ChatGPT in English language learning: a global perspective (2023)	Empirical (survey)	Bin-Hady	GenAI	Positive	Examines ChatGPT's role in English learning globally, proposing an AI-assisted language learning (AIALL) model. Highlights ChatGPT's contribution to skill development, learning support, and teaching integration. Suggests a positive impact on motivation, with further research needed on effectiveness and implementation.

DISCUSSION

The first and most pressing point to note is that 23 of the 35 papers (66%) concluded that the AI technologies under consideration have a positive effect on the motivation to learn foreign languages. Whether the AI technology in question was ASR, TTS, GenAI, or MT, the authors of these papers invariably found that these technologies were effective and motivational tools for foreign language learning.

Since we are interested in the effect that AI technologies have on the motivation to *learn* foreign languages, and since we have previously defined "learn" to mean "be able to use or understand the language in a variety of situations independently and without assistance," we should also note that the 15 empirical papers with objectively verified gains represent stronger evidence for the positive effect of AI on the motivation to learn, as compared to the 9 papers in which students or teachers merely reported an increase in motivation to learn. This is not to say that we cannot trust the statements of the teachers and students in these studies, but only that we cannot objectively verify that they have "learned" anything.

Some of the papers that had more nuanced conclusions on the use of AI-powered technologies for foreign language learning warrant further discussion here. These papers echoed the concerns expressed in the introduction to this paper, namely that AI technologies might have a negative effect on motivation to learn if they can readily be used to avoid learning. This is expressed most clearly by Moybeka et al. (2023), who state:

"While AI has great potential to motivate EFL students, there are several challenges and ethical concerns to consider. Students may become overly reliant on AI, potentially diminishing their intrinsic motivation to learn." (Moybeka et al., 2023, p.2452).

Similarly, in Voss et al. (2023), concern is expressed about allowing students to use assistive technologies in tests:

"If students were allowed to use assistive technology on language tests, the first implication would be the washback into classrooms. Teachers would allow and encourage students to use the tools and support their use to achieve higher scores on the language tests, possibly at the expense of deeper language learning. In order to demonstrate proficiency for purposes such as university admission, students may rely on the technology and not learn to compose or draft on their own. Students would be less motivated to learn to use the language independently in new and unfamiliar contexts." (Voss et al., 2023, p.11).

The concerns expressed by Moybeka et al. (2023) and Voss et al. (2023) about an *over-reliance* on AI or assistive technologies resulting in *diminished intrinsic motivation* and *lack of deeper language learning* tie into some of the theoretical frameworks discussed in the first part of this paper about what it means to "learn" foreign languages and why people are motivated to learn them.

According to Moybeka et al. (2023), intrinsic motivation is essential for long-term language learning success, and it is driven by a "love of learning and personal interest" (Moybeka et al., 2023, p.2453). And yet, in the academic and corporate worlds, the question of whether or not someone has "learned" a foreign language is answered by looking at the results of standardized tests, which are extrinsically motivating instruments. As a result of this contradiction, "teaching to the test" has become a notorious phenomenon in language learning, especially in Asian contexts (Ross, 2008), but also in any part of the world where individuals require language learning credentials for access to better education or employment opportunities.

We must, however, balance these fears against the preponderance of evidence presented in 66% of the papers analyzed in this study, which suggest or clearly show that AI technologies are indeed motivational for the learning of foreign languages. It might be that the fear of students using AI-powered technologies to avoid or negate the language learning process is overblown. On the other hand, with these kinds of empirical studies, treatments are administered in highly controlled conditions, and participants are fully aware, by means of informed consent, that they will be probed, examined, and assessed in various ways. They may simply be attempting to do and say the right things to please their teachers or the researchers in accordance with a phenomenon known as the "Hawthorne Effect" (Roethlisberger & Dickson, 1939). We should also bear in mind the possible impact of the "positive outcome bias," whereby academic research that shows the positive outcome of a certain intervention is more likely to be published than research that shows the intervention made no difference (Emerson et al., 2010).

Ultimately, there would appear to be a disconnect in the way languages are taught, where learners can make use of a range of assistive technologies or obtain help from peers and teachers, and the way language learning is assessed, which puts learners into conditions where none of these forms of assistance are available. This has led some to call for more authentic forms of assessment, where exams more closely resemble the kinds of things learners will be doing in "real-life" situations (McArthur, 2023).

Recommendations

AI-powered technologies such as TTS, ASR, MT, and GenAI were not designed with the goal of teaching or learning foreign languages in mind. These technologies can be used for learning foreign languages, but teachers need to show their students how to use them for this purpose (Moybeka 2023), especially when the learners are low-level (Chiu 2023).

Teachers will need to ensure that their students are engaging with the target language through AI-powered technologies in a way that will ultimately improve their ability to use and understand the target language independently and without assistance. From the students' point of view, it may seem unfair if their teachers are using AI to generate materials, provide practice activities, and assess written and spoken work if students themselves are not allowed to use AI to engage with materials, complete practice activities, or create written and spoken work. However, with the high number of students per teacher in most contexts of formal education, teachers may wish to take advantage of AI technologies for efficiency and productivity reasons.

However, teachers should be careful not to automate themselves out of a job. If students perceive no value in the presence of a human teacher, this may herald the end of human-led language teaching quicker than we would expect. Teachers need to understand the unique skills and abilities that they can bring to the language classroom, such as social and emotional understanding, and delegate tasks to AI only as and when appropriate.

Limitations and Future Research

This report is subject to some obvious limitations. First of all, there are the usual limitations of time and space. More time and more space would have allowed for a deeper and wider analysis of existing literature on the effect of AI-powered technologies on the motivation to learn foreign languages. In addition, the scope of this report was quite broad, focusing as it did on four different AI-powered technologies. Deeper insights on the effect on motivation of any one of these technologies might be gleaned from focusing on them individually rather than as a group. In the current study, however, it was felt that the combination of these technologies as a group presents the biggest threat to language learning as an academic discipline, especially when they can be installed onto handheld or wearable devices such as smartphones, smart glasses, or headphones.

Interesting future research directions would include in-depth studies of the viability of translation devices as a substitute for language learning and further research on the effect that AI-powered technologies have on the

motivation to learn foreign languages. It would also be interesting to investigate whether and how assessment methods might be updated to allow for the use of AI technologies.

CONCLUSION

The conclusion of this report critically depends on what it means to have "learned" something. The tentative definition offered here, in relation to foreign languages, is to be able to understand and use the language in a variety of situations independently and without assistance. In this definition, in the age of AI-powered assistive technologies, "without assistance" bears a lot of weight that it may not be able to hold when language learners graduate from formal education and enter "the real world." Here they may discover that AI affordances are embedded into the tools they use every day, such as Google Mail's translation and text prediction functions. On the other hand, in spite of rapid advances in AI, we do not yet have a "Universal Translator," and employers around the world are still looking for candidates who can use and understand foreign languages (especially English) independently and without assistance in order to effectively serve the needs of their customers and clients. Universal translators, if and when they become as ubiquitous as smartphones, will still not be as contextually and socially aware as their human users, and intrinsically motivated language learners will still have a desire to engage and interact with people from other cultures and speakers of other languages without technological intervention.

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