FOREIGN LANGUAGES AND VIETNAMESE

UNIVERSITY STUDENTS' READINESS AND USE OF INDUSTRY 4.0 TECHNOLOGIES IN FOREIGN LANGUAGE LEARNING: EVIDENCE FROM VIETNAM

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ABSTRACT: This study examines university students' readiness and capacity to master key technologies of the Fourth Industrial Revolution in the context of foreign language learning. Using a survey of 200 undergraduate students from the first to the fourth year across multiple disciplines, the research investigates learners' perceptions, levels of application, and challenges in employing technologies such as artificial intelligence (AI), the Internet of Things (IoT), big data, and automation platforms in foreign language learning. The findings indicate that students demonstrate positive attitudes and proactive engagement with digital tools to support language skills development and learning management; however, their practical application remains limited due to insufficient technological skills, experience, and career orientation integrating language and technology. The study highlights the pivotal role of higher education institutions in curriculum innovation, expanding hands-on learning opportunities, and strengthening collaboration with technology enterprises to support students in developing digital competence and mastering technology in the era of Industry 4.0.

KEY WORDS: Industry 4.0 technologies; digital competence; foreign language learning; AI application; higher education.

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1. Introduction

In the context of the rapid advancement of the Fourth Industrial Revolution, technology is exerting a profound influence on the ways people learn, work, and interact with the world. In higher education, the fast-paced development of technologies such as artificial intelligence (AI), the Internet of Things (IoT), big data, and intelligent automation has created significant opportunities for innovation in teaching and learning practices. This is particularly evident in the field of foreign language education, where technology plays a crucial role in enabling personalized learning, enhancing interaction, and improving learning effectiveness.

University students, as a young intellectual workforce preparing to enter the labor market, need not only access to but also mastery of advanced technologies in order to meet the increasingly demanding requirements of the digital society. The development of digital competence, particularly in foreign language learning, has become an essential condition for students to integrate, compete, and pursue career development in a globalized environment. Technologies such as AI-integrated language learning applications, online learning platforms, conversational chatbots, learning analytics systems, and digital classroom models are enabling learners to enhance their language skills in more flexible, effective, and personalized ways.

However, several research questions arise: Have today's university students truly mastered Industry 4.0 technologies? To what extent are their levels of understanding, application, and attitudes toward technology in foreign language learning? And how can students be supported in overcoming existing barriers and fully leveraging technological potential in foreign language learning?

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To address these questions, the study conducted a survey of 200 undergraduate students from first to fourth year across various majors at four universities: the Academy of Policy and Development (APD), Phuong Dong University (PDU), Dai Nam University (DNU), and the National University of Arts Education (NUAE). Based on the collected data, the paper analyzes the current state of students' access to technology, their level of readiness, and their capacity to master technological tools in foreign language learning. It also proposes practical solutions aimed at enhancing learners' digital competence.

The study is expected to contribute to the development of a generation of dynamic, creative, and technologically confident students in the context of digital transformation in higher education, thereby enhancing the quality of foreign language learning and the competitiveness of the young workforce in the Industry 4.0 era.

2. Literature review

The fourth industrial revolution is generating profound transformations across all sectors of society, including manufacturing, commerce, education, and governance. Core technologies of the artificial intelligence era such as artificial intelligence (AI), the Internet of Things (IoT), big data, virtual and augmented reality (VR/AR), and blockchain are reshaping the ways in which people learn, work, and interact (Schwab, 2016). In this context, higher education, particularly foreign language teaching and learning, faces an urgent need for substantial innovation in order to develop a workforce equipped with comprehensive digital competence.

2.1. Technological competence in foreign language education in the Industry 4.0 era

Numerous international studies have affirmed that mastery of Industry 4.0 technologies is a prerequisite for learners to adapt to a globalized working environment (OECD, 2020). In the field of foreign language education, artificial intelligence and digital technologies have significantly transformed teaching and learning approaches, ranging from blended learning and personalized learning to automated platforms for assessment, error analysis, and adaptive learning recommendations. Technologies such as language learning chatbots, speech recognition applications, intelligent learning management systems (LMS), and advanced machine translation are increasingly becoming familiar tools that support the development of learners' listening, speaking, reading, and writing skills.

In Vietnam, the Ministry of Education and Training (MOET, 2021) has identified digital transformation as a core mission of higher education, with digital competence and foreign language proficiency prioritized for parallel development. This highlights the close alignment between the goal of educating digital citizens and the imperative to enhance the quality of foreign language teaching and learning.

2.2. The current state of university students' technological competence in foreign language learning

Although Vietnamese students demonstrate a high level of access to technology through the use of online learning platforms (e.g., Zoom, Google Meet, and LMS) and foreign language learning support tools (such as vocabulary applications and translation tools), numerous studies indicate that they still lack foundational knowledge of artificial intelligence, data analytics, and advanced technological skills for academic purposes (Nguyen & Tran, 2021). In particular, the application of Industry 4.0 technologies in foreign language learning remains largely ad hoc, insufficiently guided, and highly dependent on technical conditions as well as the level of institutional support provided by higher education institutions.

Other identified barriers include limited foreign language proficiency when accessing international materials, a lack of technology-rich practice environments, and insufficient opportunities to experience innovative technological applications (Le & Pham, 2022). These constraints reduce the effectiveness of leveraging Industry 4.0 tools for the development of foreign language skills as well as students' lifelong learning capacity.

2.3. Models and strategies for developing digital competence in foreign language learning

Globally, models such as flexible learning**,** personalized learning, and technology-integrated learning have been demonstrated to be effective in enhancing students' technological competence and foreign language proficiency (Redecker, 2017). Leading universities have also implemented AI-integrated language laboratories**,** VR-based simulation practices**,** intelligent tutoring systems, and industry-collaborative projects with technology companies to provide students with authentic and practice-oriented learning experiences.

In Vietnam, many higher education institutions are gradually implementing similar strategies; however, the level of coherence and effectiveness remains limited. Students still require stronger support from institutional policies, clearer guidance from instructors, and curricula designed in alignment with digital competence standards.

2.4. Research gap

A synthesis of both international and domestic literature indicates that Industry 4.0 technological competence plays a pivotal role in foreign language learning in higher education. Vietnamese university students are generally familiar with the use of basic technologies; however, they still lack sufficient knowledge and skills to effectively exploit advanced technologies for foreign language learning purposes. Moreover, existing domestic studies remain limited in terms of large-scale surveys and empirical evidence assessing students' technology readiness within the context of foreign language learning.

Building upon this theoretical and empirical foundation, the present study contributes additional survey data from university students to examine the current state of technological readiness and technology mastery, and to propose practical solutions for enhancing students' capacity to effectively utilize Industry 4.0 technologies in foreign language learning in Vietnam.

Research questions:

1/ What is the level of technology readiness and the extent of application of Industry 4.0 technologies among university students in foreign language learning?;

2/ What are the major challenges and barriers that university students face in mastering Industry 4.0 technologies for foreign language learning?;

3/ What solutions from higher education institutions, instructors, and students themselves can enhance students' capacity to effectively master and utilize Industry 4.0 technologies in foreign language learning within the context of Vietnamese higher education?

3. Methology

3.1. Research design

This study employed a quantitative survey design supplemented by open-ended questions. The quantitative data were used to examine students' technology readiness, digital competence, and patterns of technology use in foreign language learning. Responses to the open-ended questions provided additional insights into students' experiences, perceptions, and challenges when engaging with Industry 4.0 technologies. Together, these data offered a more comprehensive understanding of students' technology-related learning experiences.

3.2. Research participants

The study involved 200 undergraduate students aged 18 to 22 years from first- to fourth-year levels, drawn equally from four higher education institutions in Vietnam: the Academy of Policy and Development (APD), Phuong Dong University (PDU), Dai Nam University (DNU), and the National University of Arts Education (NUAE), with 50 participants recruited from each institution. The sample consisted of 80 male students (40%) and 120 female students (60%), representing a balanced distribution across different academic years and educational contexts. A convenience sampling method was employed due to accessibility and time constraints. While the sample was distributed across the four institutions to enhance diversity in academic backgrounds and learning environments, it was not intended to be statistically representative of the entire population of Vietnamese university

students. Participants came from a variety of academic disciplines, including English Language Studies, Business Administration, Economic Law, Tourism, Economics, Accounting and Finance, and Banking and Finance. This diversity provided a broader perspective on students' perceptions and experiences regarding technology-enhanced foreign language learning in higher education.

3.3. Research instruments

The research instrument was a structured questionnaire consisting of four sections, developed based on the digital competence frameworks proposed by the OECD (2020) and Redecker (2017):1/ Demographic information, including age, gender, academic major, and year of study; 2/Technology readiness in foreign language learning, focusing on the use of learning management systems (LMS), AI-powered language learning applications, VR/AR technologies, and mobile learning tools; 3/ Challenges and barriers, such as technological infrastructure, pedagogical support, and language-related limitations; 4/ Learning needs and expectations, including preferred training formats, technical support, and desired levels of technology integration.

Sections 2-4 employed a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) to measure participants' responses. In addition, open-ended questions were included to capture more detailed insights into students' experiences and perceptions. The scales demonstrated good reliability, with Cronbach's alpha coefficients ranging from 0.82 to 0.91.

3.4. Data collection and analysis

Data were collected through an online questionnaire developed using Google Forms and distributed to students at the four participating institutions between September and November 2025. Participation was voluntary, and respondents were informed of the study's purpose and assured of their anonymity and confidentiality. The questionnaire gathered demographic information and explored students' experiences with digital technology in foreign language learning. After data collection, the responses were screened, coded, and analyzed using Excel and SPSS Statistics. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to examine students' technology readiness, usage patterns, perceived benefits and challenges. The analysis aimed to provide an overview of students' experiences rather than test causal relationships. Responses to the open-ended questions were reviewed and used to provide additional context for interpreting the quantitative findings. These responses offered further insights into students' experiences, perceptions, and challenges related to the use of Industry 4.0 technologies in foreign language learning. As the study relied on self-reported data, the findings should be interpreted as reflecting the participants' perceptions and experiences rather than objective measures of competence or learning outcomes.

4. Findings and discussion

4.1. University students' level of access to and use of Industry 4.0 technologies in foreign language learning

The survey results indicate that students have substantial exposure to Industry 4.0 technologies in the context of foreign language learning. Among the technologies examined, artificial intelligence (AI) was the most commonly used (94.5%), followed by Big Data (82.5%) and the Internet of Things (IoT) (75%). These patterns were observed across a diverse group of undergraduate students from first- to fourth-year levels and a wide range of academic disciplines, including English Language Studies, Business Administration, Economic Law, Tourism, Economics, Accounting and Finance, and Banking and Finance. This pattern reflects a preference for technologies that support everyday learning activities, particularly content personalization and learning progress tracking. Virtual and augmented reality (VR/AR) (52%) shows considerable potential but remains constrained by implementation conditions and users' skill levels. In contrast, blockchain (31%) and 3D printing (26%) are far less commonly encountered, indicating that these technologies have not yet become familiar to students. The findings suggest that students are generally comfortable using technologies that have become part of their regular learning activities. By contrast, more advanced tools that

support personalized and self-directed learning are used less frequently, which may be related to limited digital skills, insufficient institutional support, and a lack of structured learning opportunities.

The survey results show that students demonstrate a relatively proactive attitude toward keeping up with trends and technologies supporting foreign language learning. More than half of the students (55%) reported regularly keeping up with developments in AI, mobile learning applications, and speaking-practice platforms. A further 42% indicated that they updated their knowledge from time to time, while only 3% did so infrequently. Importantly, none of the respondents stated that they never followed developments in these technologies. This pattern suggests that technology has become a familiar component of students' learning practices and that the trend toward digitalization in higher education is increasingly evident. However, the gap between the "regular" and "occasional" groups highlights the need for more systematic orientation, support, and integration of technology-based activities in order to encourage students to move from awareness to more proactive and sustainable learning behaviors.

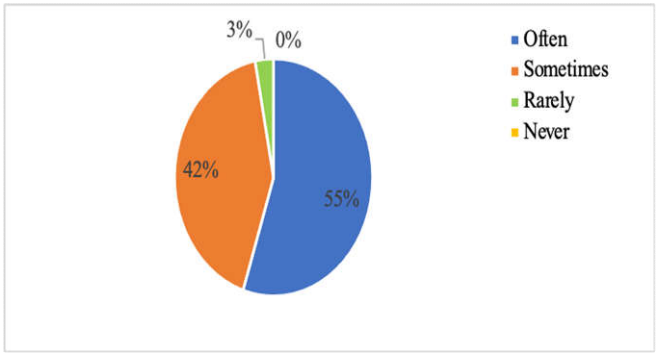


Figure 1. *Level of proactiveness in updating trends and technologies for foreign language learning*

Source: Compiled by the authors

Regarding the level of understanding, 50% of students self-assessed their knowledge as fairly clear, 42% as moderate, 6% as very clear, and 2% as unclear. This distribution indicates that the majority of students have developed a basic awareness of Industry 4.0 technologies; however, the proportion of those with in-depth understanding and the ability to apply these technologies effectively remains limited. This finding highlights the need to strengthen systematic training and guided support activities in order to enhance students' understanding and capacity to exploit Industry 4.0 technologies for effective and sustainable foreign language learning.

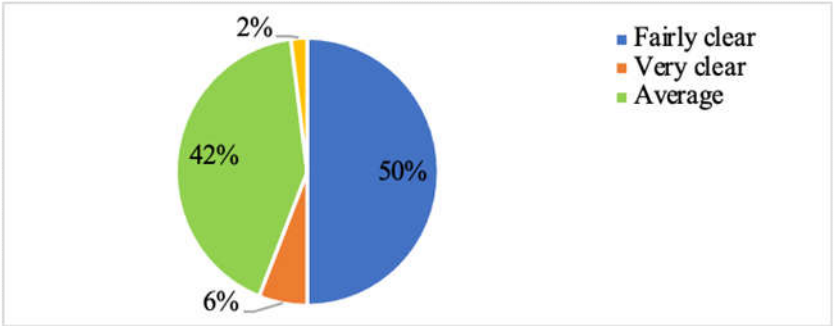


Figure 2. *Students' self-assessed level of understanding of Industry 4.0 technologies in foreign language learning*

ynthesizing the two sets of findings reveals a gap between students' levels of exposure to and proactive updating of technology and their depth of understanding. While students are generally

willing to adopt new technologies, they still lack a solid knowledge base and systematic guidance to effectively exploit Industry 4.0 technologies in foreign language learning. This gap underscores the importance of structured training and support programs in transforming technological awareness into practical application competence.

4.1.1. Technology-use skills for foreign language learning

When asked whether they had ever taken formal courses in technology-related fields such as programming, artificial intelligence, or big data, the survey revealed that 36.5% of students had participated in such courses, whereas 63.5% had not received any formal training. The predominance of students without a technological foundation suggests that their engagement with Industry 4.0 technologies is largely driven by self-directed learning and experiential exposure rather than systematic education. This helps explain the disparities in students' proficiency with advanced technologies in foreign language learning. These findings highlight the need to integrate technology and AI-literacy modules or professional development courses into university curricula in order to establish a more equitable foundation and support students in using technology effectively and in a guided manner.

***Table 1**. Students' technology-use skills for foreign language learning (N = 200)*

Survey items	Mean	SD	Percentage (%)				
			Very proficient (%)	Proficient (%)	Average (%)	Weak (%)	Very weak (%)
1. Skills in using online foreign language learning platforms	3.56	0.88	14.0	36.0	43.0	6.0	1.0
2. Skills in using AI-powered tools for language learning	3.38	1.12	20.5	25.5	33.5	12.0	8.5
3. Skills in using speech recognition for pronunciation practice	3.15	1.03	13.0	22.0	38.0	20.5	6.5
4. Skills in using LMSs and online English-language resources	3.54	0.91	19.0	28.5	41.5	9.5	1.5

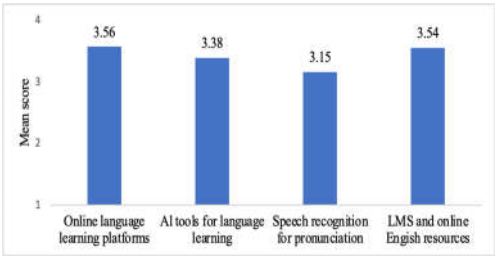


***Figure 3.** Students' technology skills in foreign language learning*

The survey results indicate that students' technology-use skills for foreign language learning range from moderate to fairly good levels, with mean scores varying from 3.15 to 3.56 on a five-point Likert scale. This reflects a moderate level of ability to access technology; however, the level of mastery remains limited and varies across different types of technologies. Specifically, skills in using online foreign language learning platforms (e.g., Duolingo, Memrise, ELSA) recorded the highest level (Mean = 3.56; SD = 0.88), with 50% of students self-reporting that they were proficient or very proficient, indicating the popularity and accessibility of these platforms. Nevertheless, a substantial

proportion of students remained at an average level (43%), suggesting that their use tends to be more supportive than strategic. Competence in using learning management systems (LMS) and online English-learning resources was rated relatively positively (mean = 3.54, SD = 0.91). Despite this, students tended to engage with these tools primarily for coursework, while self-directed use for language development appeared less common. Regarding AI-assisted tools for foreign language learning, the mean score reached 3.38 (SD = 1.12), with a clear polarization: alongside a group of students who use these tools effectively, 20.5% were at weak or very weak levels, reflecting a gap in AI literacy. Speech recognition technologies recorded the lowest mean score (Mean = 3.15; SD = 1.03), indicating that advanced pronunciation-training technologies have not yet been widely exploited.

When situated within the DigComp framework (Redecker, 2017; European Commission, 2022) and the concept of AI literacy (Ng et al., 2021; UNESCO, 2023), the findings indicate that students' digital competence remains largely at the level of tool use rather than strategic mastery of technology. This underscores the need to strengthen pedagogical guidance, provide systematic digital skills training, and more deeply integrate technology into foreign language courses in order to enhance learning effectiveness and students' autonomous learning capacity in the context of digital transformation.

4.1.2. Students' perceptions of the role of Industry 4.0 and their desire for mastery

Regarding students' perceptions of the role of Industry 4.0 technologies and their desire to master them in foreign language learning, the survey results indicate a highly positive awareness and a high level of readiness among students. Specifically, 95% of students expressed a desire to learn more about Industry 4.0 technologies to support their foreign language learning, while only 5% reported no such need. At the same time, 92.5% of respondents rated Industry 4.0 technologies as important or very important, with 53.5% selecting the "very important" level. These findings suggest that students not only view technology as a supportive learning tool but also clearly recognize the strategic role of Industry 4.0 technologies in enhancing professional competence in the context of digital transformation.

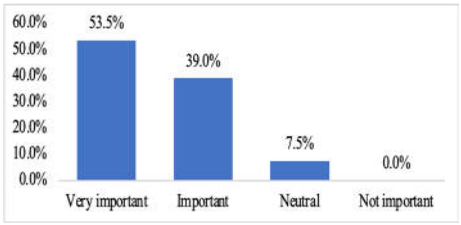


Figure 4. *Perceived importance of industry 4.0*

However, when self-assessing their level of mastery of Industry 4.0 technologies in foreign language learning, the results show that students' practical mastery remains limited despite high awareness. The majority of students reported that they were still in the process of learning (76%) or had only just begun to engage with these technologies (15%), while only 4% considered themselves to have achieved a good level of mastery, and 5% indicated a lack of genuine interest. This finding suggests that, despite students' appropriate awareness and positive attitudes, their technological mastery remains disproportionate, reflecting a common challenge in contemporary foreign language education: access to technology does not necessarily equate to mastery of technology.

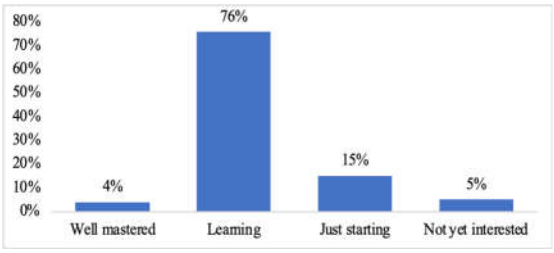


***Figure 5**. Self-assessed mastery of Industry 4.0*

Students' expectations of institutional support further help to elucidate this gap. Practice-based and experiential support emerged as students' preferred form of assistance, with hands-on guidance through real-world projects identified as the most favored option, selected by 30% of respondents. This is followed by collaboration with enterprises to provide opportunities for technological exposure (27%). Foundational support measures, such as the provision of digital skills training courses (20.5%) and technology-related career orientation and guidance (22.5%), are also highly valued. These results indicate that students not only require technological knowledge but also aspire to develop the capacity to apply technology effectively within specific learning and professional contexts.

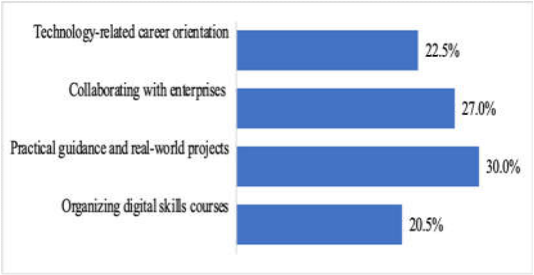


***Figure 6.** Students' expectations regarding institutional support*

From a discussion perspective, the above findings confirm that students have developed appropriate awareness and strong learning motivation toward mastering Industry 4.0 technologies in foreign language learning. However, the lack of well-structured, practice-oriented learning opportunities that are closely aligned with professional contexts may account for the limited level of technological mastery observed among students. Therefore, to narrow the gap between awareness and competence, foreign language training programs should shift their focus from merely "using technology" to "mastering and applying technology," by integrating real-world projects, technology-based experiential activities, and industry collaboration into the foreign language teaching and learning process.

4.1.3. Students' ability to apply technology in foreign language learning

The results indicate that students perceive themselves as moderately capable of applying technology for self-study, skills development, and learning analytics, though the relatively high standard deviations suggest variability in individual digital competence.

***Table 2**. Students' ability to apply technology in foreign language learning (N = 200)*

Survey items	Mean	SD	Percentage (%)				
			Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)
1.Application of technology to support autonomous foreign language learning	3.73	0.92	19.0	48.0	21.5	10.5	1.0

2. Use of technology to enhance listening, speaking, reading, and writing skills	3.56	0.98	19.5	37.0	27.5	12.0	4.0
3. Ability to use learning analytics to monitor learning progress	3.85	0.86	18.7	54.9	18.7	7.7	0.0

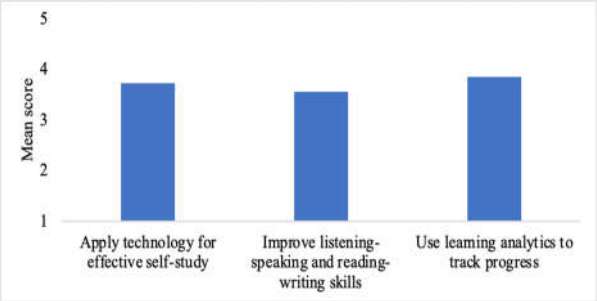


Figure 7. *Students' ability to apply technology in foreign language learning*

The survey results indicate that students hold positive perceptions of their ability to apply technology to foreign language learning, with mean values ranging from 3.56 to 3.85 on a five-point Likert scale. This suggests that students have developed a moderate-to-good level of digital competence, which is consistent with the description of basic competence levels in the European Union's DigComp framework (Redecker, 2017; European Commission, 2022).

Specifically, the statement *"The application of technology (AI, software, and mobile applications) can support effective autonomous foreign language learning"* achieved a mean score of 3.73 (SD = 0.92), with 67% of students indicating agreement or strong agreement. This result reflects students' readiness for self-directed learning, in which learners proactively plan, monitor, and regulate their learning processes with the support of technology (Zimmerman, 2002). However, the proportion of students who selected the neutral option (21.5%) suggests that technology-mediated self-learning has not yet fully developed into a conscious and sustainable learning strategy for all learners.

Regarding the ability to *"use technology to improve listening-speaking and reading-writing skills,"* the mean score was 3.56 (SD = 0.98). Although more than half of the students expressed positive attitudes, 16% disagreed or strongly disagreed, indicating limitations in translating technological potential into effective development of specific language skills. This finding reflects challenges in the *Problem solving* and *Digital content creation* domains of the DigComp framework, as learners have not yet fully mastered technology to generate meaningful language output and enhance communicative competence (European Commission, 2022).

Among the surveyed items, the ability to use learning analytics to track progress in foreign language learning received the highest rating (Mean = 3.85, SD = 0.86), with 73.6% of respondents reporting agreement or strong agreement. This result suggests a high level of student readiness to engage with learning analytics, which are widely regarded as important tools for supporting self-monitoring and reflective learning (Siemens & Baker, 2012). However, according to the DigComp framework, effective use of learning analytics also requires competencies in data analysis, interpretation, and data-informed decision-making, areas in which students may not yet have received systematic training (Redecker, 2017).

Overall, the findings indicate that students have developed positive awareness and attitudes toward the application of technology in foreign language learning; however, their current competence largely remains at the level of tool usage. This reinforces the view that the integration of technology

into foreign language teaching should be accompanied by the systematic development of DigComp-related competencies, self-regulated learning, and learning analytics within a clear pedagogical framework, rather than merely encouraging spontaneous or unguided use of technology (Ng et al., 2021; UNESCO, 2023).

4.2. Challenges in students' mastery of Industry 4.0 technologies

4.2.1. General difficulties in using Industry 4.0 technologies for foreign language learning

Regarding the question of difficulties in accessing Industry 4.0 technologies in foreign language learning, the survey results reveal that students face numerous challenges in both accessing and applying Industry 4.0 technologies to their language studies. Among the identified barriers, a lack of foundational knowledge of technologies such as artificial intelligence (AI), the Internet of Things (IoT), and Big Data accounts for the highest proportion (41%), indicating a significant limitation in learners' core digital competencies. This finding is consistent with the observations of Nguyen and Tran (2021), who argue that Vietnamese students predominantly use technology at a basic level while lacking the theoretical knowledge and practical skills necessary to effectively exploit advanced technologies.

In addition, language barriers account for 22%, reflecting students' difficulties in comprehending English-language materials and technical instructions, which in turn limits their access to contemporary platforms and applications for foreign language learning. Other factors, including a lack of devices (13%), low confidence in using technology (10%), and time constraints (7%), also contribute to hindering the application of technology in learning, particularly in a context where digital infrastructure at many educational institutions is still in the process of development. The results indicate that students have not yet fully developed the capacity to use technology in a purposeful and systematic manner for foreign language learning. Addressing this issue requires greater investment in digital skills training, technological infrastructure, and instructional support.

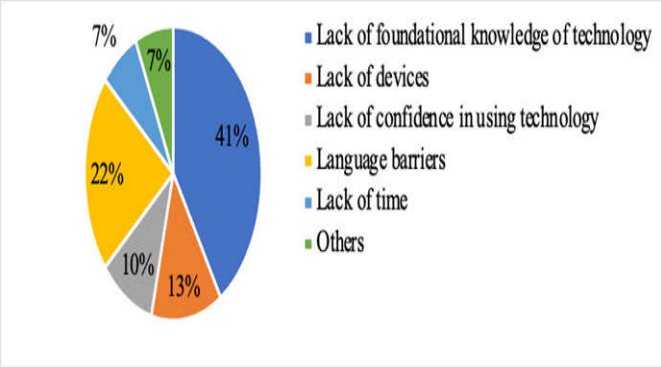


Figure 8. *Difficulties in accessing Industry 4.0 technologies in foreign language learning*

4.2.2. Specific difficulties in using technology for foreign language learning

The results show that language proficiency barriers and lack of lecturer guidance are perceived as more challenging than infrastructure-related issues, with relatively high standard deviations indicating variability in students' experiences.

Table 3*. Perceived difficulties in using technology for foreign language learning* (N = 200)

Survey items	Mean	SD	Percentage (%)				
			Very difficult (%)	Difficult (%)	Moderately difficult (%)	Slightly difficult (%)	Not a difficulty (%)
1.Difficulties in using technology due to limited English proficiency	3.37	0.97	10.5	37.5	33.0	16.5	2.5

2. Difficulties in using new technologies due to insufficient instructor guidance	3.29	1.02	14.0	29.0	34.0	18.5	4.5
3. Difficulties in applying technology due to limited devices or unstable internet access	3.07	1.11	13.0	22.0	35.0	19.0	11.0

The survey results indicate that students experience difficulties ranging from moderate to relatively high levels when applying technology to foreign language learning, with mean scores between 3.07 and 3.37. The most prominent difficulty relates to limited vocabulary and English language proficiency (Mean = 3.37; SD = 0.97), reflecting language barriers that affect students' ability to access and effectively exploit technological platforms, in line with the *information and data literacy* requirements of the DigComp framework (European Commission, 2022). The lack of instructor guidance when using new technologies (Mean = 3.29; SD = 1.02) highlights the pivotal role of teachers in the development of students' digital competence (Redecker, 2017). Difficulties caused by a lack of devices or unstable internet connectivity are relatively lower (Mean = 3.07; SD = 1.11) but nevertheless point to limitations in technical infrastructure (UNESCO, 2023). Overall, the findings suggest that many students still face difficulties in applying technology effectively and consistently in foreign language learning. This highlights the need for stronger language support, more structured pedagogical guidance, and continued investment in technological infrastructure within higher education.

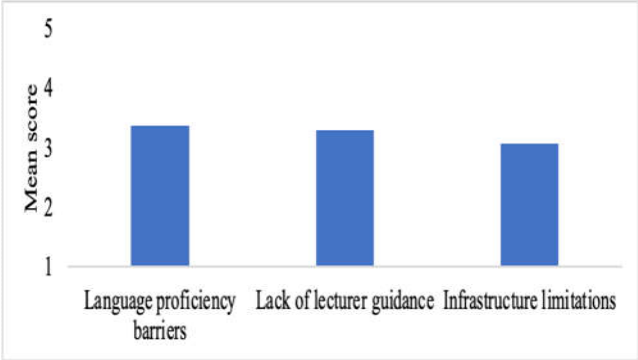


Figure 9. *Perceived difficulties in using technology for foreign language learning*

In both subsections 4.2.1 and 4.2.2, the survey results reveal a significant gap between the potential of Industry 4.0 technologies in foreign language learning and students' ability to implement them effectively. Although Industry 4.0 technologies can promote personalized learning, autonomous learning, and the development of language competence, students currently use these technologies mainly at a basic level, without achieving true mastery. The barriers include a lack of foundational technological knowledge, limited English proficiency, insufficient pedagogical guidance from instructors, and unstable infrastructure, indicating that students' digital competence has not kept pace with technological advancements. As a result, the innovative potential of Industry 4.0 has not yet been translated into substantive learning outcomes, stemming from a lack of alignment among learner competence, pedagogical support, and implementation conditions in higher education.

4.3. Institutional training environment and support for technology-enhanced foreign language learning

***Table 4**. Institutional training environment and support for technology-enhanced foreign language learning (N = 200)*

Survey items	Mean	SD	Percentage (%)				
			Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)
1. The institution provides adequate digital platforms to support foreign language learning (e.g., LMS, speaking practice software, etc.)	3.95	0.98	34.5	39.0	17.0	6.0	3.5
2. Foreign language instructors actively integrate technology into their teaching	4.22	0.84	37.4	48.4	13.2	1.1	0.0
3. Students have opportunities to experience new technologies (AI, VR/AR, chatbots) in foreign language courses	3.92	1.01	34.1	35.2	20.9	8.8	1.1
4. Foreign language training programs need to integrate Industry 4.0 technologies more extensively	4.10	0.95	40.0	39.5	14.5	2.5	3.5

The survey results indicate that students hold positive evaluations of the institutional training environment and the level of support provided by the university for the application of technology in foreign language learning, with mean scores ranging from 3.92 to 4.22. These findings suggest that the learning environment provides conditions that are broadly conducive to the development of digital competence, as emphasized in contemporary digital competence frameworks (European Commission, 2022). The survey item *"Foreign language instructors actively integrate technology into their teaching"* received the highest score (Mean = 4.22; SD = 0.84), with nearly 86% of students agreeing or strongly agreeing. This highlights the pivotal intermediary role of instructors in transforming technological infrastructure and tools into meaningful learning experiences (Redecker, 2017).

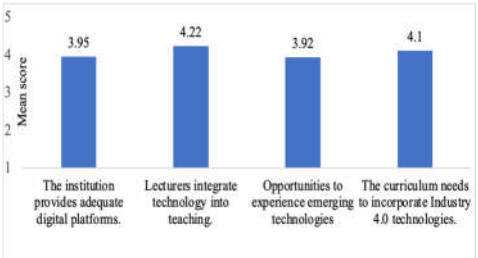


***Figure 10.** Institutional training environment and support for technology-enhanced foreign language learning*

The provision of digital platforms by the institution achieved a mean score of 3.95, indicating that the infrastructure relatively meets students' needs. However, 17% of respondents were neutral and 9.5% disagreed, reflecting disparities in access and effective usage, particularly in technology-intensive courses. These findings underscore that infrastructure only realizes its full value when accompanied by policies for training, digital competence support, and alignment among the curriculum, instructors, and students (European Commission, 2022). Students also expressed strong agreement regarding the need for greater integration of Industry 4.0 technologies into the curriculum (Mean = 4.10) and opportunities to experience new technologies (Mean = 3.92), indicating that the potential of AI, VR/AR, and chatbots has not yet been implemented consistently.

Overall, the institution and instructors play a decisive role in shaping a digital learning environment that supports students in developing DigComp competencies, enabling the transition from mere access to effective use of technology. At the same time, these findings highlight the need for investment in infrastructure, the enhancement of instructors' digital competencies, and curriculum innovation aimed at systematic technology integration (Redecker, 2017; UNESCO, 2023).

4.4. Students' support needs in technology-enhanced foreign language learning

Table 5*. Students' support needs in technology-enhanced foreign language learning (N = 200)*

Survey items	Mean	SD	Percentage (%)				
			Highly necessary (%)	Necessary (%)	Neutral (%)	Less necessary (%)	Not necessary (%)
1. The need for integrated digital skills courses and experiential learning opportunities	4.17	0.74	38.5	44.5	13.5	3.0	0.5
2. The need for workshops on the use of language learning technologies (e.g., AI and learning applications)	4.16	0.76	38.5	43.5	14.0	3.5	0.5
3. The need for guidance on technology-integrated learning pathways and industry collaboration for practical experience	4.21	0.71	43.0	38.5	15.0	3.0	0.5

The survey results indicate that students demonstrate a very high demand for technology-enhanced foreign language learning support, as reflected in consistently high and stable mean values (Mean = 4.16-4.21; SD = 0.71-0.76). Guidance on technology-integrated learning pathways emerged as the most strongly endorsed form of support, receiving the highest mean score (Mean = 4.21). Students also highlighted the value of practical learning opportunities, particularly through collaboration with technology-related enterprises. These findings suggest that students are concerned

not only with technological tools but also with systematic guidance aligned with real-world professional contexts.

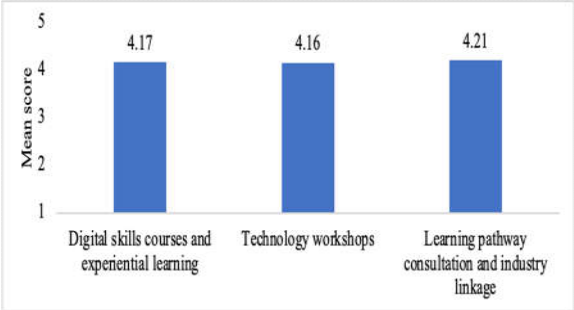


Figure 11. *Students' technology skills in foreign language learning*

These findings align with previous studies on the development of digital competence, which emphasizes the development of digital competence through experiential practice, lifelong learning, and alignment with professional contexts (Ferrari, 2013; Vuorikari et al., 2022). The high demand for workshops providing guidance on the use of AI and foreign language learning applications also reflects limitations in students' self-regulated learning capacity. According to Zimmerman (2002), effective self-directed learning can only be achieved when learners are equipped with appropriate strategies and initial scaffolding. Furthermore, students' desire for strengthened collaboration between higher education institutions and technology enterprises aligns with the OECD's (2021) assertion regarding the critical role of such partnerships in narrowing the gap between education and labor market demands.

Overall, the results highlight the central role of educational institutions in supporting students' transition from merely 'using technology' to 'mastering technology' in foreign language learning

4.5. Solutions for enhancing students' capacity to master Industry 4.0 technologies in foreign language learning

Based on the analysis of the identified challenges, several solution directions have been proposed to support students in enhancing their technological competence within the context of Vietnamese higher education.

First, it is essential to strengthen digital skills training programs for students, particularly skills directly related to Industry 4.0 technologies, such as the use of AI in foreign language learning, learning analytics, advanced digital competencies, and self-directed learning skills in digital environments. Integrating technology-focused training modules into foreign language curricula can help students develop a more systematic and effective capacity for technology application.

Second, the role of instructors should be strengthened through pedagogical innovation that enhances digital interaction and leverages technology-supported assessment and personalized learning activities. Instructors need to be professionally trained to effectively use Industry 4.0 tools, thereby enabling them to guide students in selecting and exploiting appropriate technological platforms.

Third, higher education institutions should make greater investments in technological infrastructure, including AI-integrated language laboratories, smart classrooms, and learning management systems (LMS) capable of tracking, analyzing, and optimizing students' learning progress. Collaboration with technology enterprises to implement experiential learning models is also an effective solution.

Finally, students themselves need to enhance their learner autonomy by proactively exploring, experimenting with, and evaluating emerging technological tools. Developing a lifelong learning

mindset and the capacity to adapt rapidly to technological change are key factors enabling students to truly master technology within foreign language learning environments.

5. Conclusion

This study examined university students' technological competence and support needs in technology-enhanced foreign language learning within the context of Industry 4.0 in Vietnamese higher education. The findings indicate that although students demonstrate positive attitudes toward technology and increasing exposure to Industry 4.0 tools, their use of these technologies remains largely basic and fragmented. The results highlight the importance of strengthening digital competence, pedagogical support, and technological infrastructure to enable more effective technology integration in foreign language learning.

This study has several limitations. First, the use of convenience sampling and the inclusion of students from only four universities may limit the generalizability of the findings. Second, the study relied on self-reported data, which may not fully reflect students' actual levels of digital competence and technology use. Third, the research focused primarily on students' perceptions and experiences rather than objective measures of learning performance. Future studies could employ larger and more diverse samples and incorporate objective indicators of technology use and learning outcomes.

Despite these limitations, the study provides valuable insights into university students' readiness, challenges, and support needs regarding the use of Industry 4.0 technologies in foreign language learning. The findings contribute to ongoing discussions on digital transformation in higher education and underscore the importance of developing students' digital competence through pedagogically meaningful and contextually relevant technology integration.

REFERENCES

1. European Commission (2022), *The Digital Competence Framework for Citizens: DigComp 2.2.* Publications Office of the European Union.
2. Ferrari, A. (2013), *DIGCOMP: A framework for developing and understanding digital competence in Europe.* Publications Office of the European Union. https://doi.org/10.2788/52966.
3. Le, V. T., & Pham, T. A. (2022), Difficulties and technological learning needs of Vietnamese university students. In *Proceedings of the 2022 Higher Education Conference*. Vietnam National University Ho Chi Minh City.
4. Ministry of Education and Training (2021), *Digital transformation program for the education sector to 2025, with a vision to 2030.*
5. Ng, D. T. K., Leung, J. K. L., Chu, K. W. S., & Qiao, M. S. (2021), AI literacy: Definition, teaching, evaluation and ethical issues. *Proceedings of the Association for Information Science and Technology, 58*(1), 504-509.
6. Nguyen, T. H., & Tran, M. Q. (2021), Digital competence of university students in the context of educational digital transformation in Vietnam. *Journal of Educational Sciences, 18*(2), 45-52.
7. OECD. (2020), *Skills for a digital world.* https://www.oecd.org/
8. OECD. (2021), *OECD digital education outlook 2021: Pushing the frontiers with artificial intelligence, blockchain and robots.* OECD Publishing. https://doi.org/10.1787/589b283f-en.
9. Redecker, C. (2017), *European framework for the digital competence of educators: DigCompEdu.* Publications Office of the European Union.
10. Schwab, K. (2016), *The fourth industrial revolution.* World Economic Forum.
11. Siemens, G., & Baker, R. S. J. d. (2012), Learning analytics and educational data mining: Towards communication and collaboration. In *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge* (pp. 252–254).

12. UNESCO. (2023), *Guidance for generative AI in education and research.* UNESCO Publishing.
13. Vuorikari, R., Kluzer, S., & Punie, Y. (2022). *DigComp 2.2: The Digital Competence Framework for Citizens-With new examples of knowledge, skills and attitudes.* Publications Office of the European Union. https://doi.org/10.2760/115376.
14. Zimmerman, B. J. (2002), Becoming a self-regulated learner: An overview. *Theory Into Practice, 41*(2), 64-70. https://doi.org/10.1207/s15430421tip4102_2.

Năng lực làm chủ các công nghệ 4.0 trong học tập ngoại ngữ của sinh viên đại học: nghiên cứu tình huống

Tóm tắt: Bài viết phân tích mức độ sẵn sàng và khả năng làm chủ các công nghệ chủ chốt của Cách mạng công nghiệp 4.0 trong học ngoại ngữ của sinh viên đại học. Nghiên cứu khảo sát 200 sinh viên từ năm thứ nhất đến năm thứ tư thuộc nhiều chuyên ngành nhằm đánh giá nhận thức, mức độ ứng dụng và những khó khăn khi triển khai các công nghệ như trí tuệ nhân tạo (AI), Internet vạn vật (IoT), dữ liệu lớn và các nền tảng tự động hóa. Kết quả cho thấy sinh viên có thái độ tích cực và chủ động tiếp cận công nghệ trong luyện kỹ năng ngôn ngữ và quản lý học tập, song khả năng ứng dụng thực tiễn còn hạn chế do thiếu kỹ năng công nghệ, kinh nghiệm và định hướng nghề nghiệp gắn với ngoại ngữ - công nghệ. Trên cơ sở đó, nghiên cứu nhấn mạnh vai trò của nhà trường trong đổi mới chương trình, tăng cường trải nghiệm thực hành và hợp tác với doanh nghiệp công nghệ nhằm hỗ trợ sinh viên phát triển năng lực số và làm chủ công nghệ trong bối cảnh giáo dục đại học thời đại 4.0.

Từ khóa: Công nghệ 4.0; năng lực số; học ngoại ngữ; ứng dụng AI; giáo dục đại học.