iafor

journal of education technology in education

Volume 12 – Issue 2 – 2024

Editor: Michael P. Menchaca

ISSN: 2187-0594

iafor

IAFOR Journal of Education: Language Learning in Education
Volume 12 – Issue 2 – 2024

IAFOR Publications

The International Academic Forum

IAFOR Journal of Education: Technology in Education

Published by The International Academic Forum (IAFOR), Japan
IAFOR Publications, Sakae 1-16-26-201, Naka-ward, Aichi, Japan 460-0008

IAFOR Publications Assistant: Mark Kenneth Camiling
Publications Manager: Nick Potts

IAFOR Journal of Education: Technology in Education
Volume 12– Issue 2 – 2024

Published August, 2024

ISSN: 2187-0594

ije.iafor.org

Cover Image: Andy Kelly, Unsplash

IAFOR Journal of Education: Technology in Education

Volume 12 – Issue 2 – 2024

Edited by Michael P. Menchaca

Associate Editor: Daniel L. Hoffman

Associate Editor: Devayani Tirthali

Table of Contents

From the Editors

The editors of *IAFOR's Journal of Education: Technology in Education* welcome you to peruse this issue's collection of articles exploring technology's continued influence of education! Most notably, a post-pandemic increased comfort with technology-mediated virtual educational settings coupled with the rapid development of AI has moved the field of education to a new normal. The articles in this special issue engage with the challenges and opportunities brought on by this shift as well as the need for newer conceptualisations.

Four of the articles underscore the evolving role of AI and Machine Learning (ML) in education, the opportunities and challenges such evolution poses to traditional teaching and assessment, and the need to equip students and educators with skills necessary to navigate the complexities of AI-driven innovation. The remaining three articles discuss implications of "the virtual," ranging from the experience of first year students in a hybrid course to techno-pedagogical models for virtual Language learning classrooms to shifting conceptualisations of international students in the age of virtual student exchange programs.

The articles examine these aspects of technology in education using a diverse array of methods including experimental design with intervention, exploratory qualitative inquiry, phenomenological investigation, surveys, and design research. Continuing the diversity of global engagement, this year we offer articles written by authors spanning countries from east to west including South Korea, Japan, Thailand, The Philippines, Uzbekistan, Azerbaijan, Croatia, and Mexico. Thus, supporting IAFOR's commitment encouraging interdisciplinary discussion, facilitating intercultural awareness, and promoting international exchange, this year we present the following seven thought provoking articles.

The first article integrates two theoretical models to provide a nuanced analysis of factors influencing AI adoption in instructional practices by private school teachers in Azerbaijan. The study will be of interest to educators, school administrators, and policymakers as it explores factors such as individual teacher characteristics, perceived usefulness, ease of use, and the broader institutional environment in shaping educators' willingness to integrate AI in their practice. Bakhadirov, Alasgarova, and Rzayev argue that a supportive policy environment and a culture promoting AI usage among colleagues are pivotal in driving adoption, often more so than individual innovativeness or openness to new experiences.

Article two examines the ethical conundrum of using ChatGPT for writing homework assignments in university settings. Krecar, Kolega, and Jurcec first investigate Croatian students' attitudes, usage patterns, and ethical considerations about using ChatGPT for writing homework assignments. Second, they assess professors' abilities to distinguish between student-written and AI-generated content, juxtaposing that with their perception of the efficacy to do so. Although the study found most students' ethical compass intact, professors' lack of efficacy to differentiate between student and AI-generated content was concerning. The authors provide a substantive discussion about the way forward for upholding academic integrity given these realities.

Focused on instructional design, the third article delves into how future designers can be educated to effectively utilize ML technologies while maintaining a strong focus on user-centric design principles. ML applications touted to enhance user experience (UX) across various platforms have failed in reality, often due to a misalignment between technological capabilities and actual user needs. The seven-week course developed by Jung and Lee seeks to bridge this gap by fostering a more holistic approach to ML in UX design, where the human element is not just considered but prioritized. The authors provide details of the methodology and course structure, offering valuable insights for educators looking to incorporate critical thinking and the cultivation of innovation in their design curricula.

The fourth article focuses on the significant transformation in the concept of an "international student" brought on by the advent of virtual study abroad programs. Enkhtur and Li highlight the tension between the traditional definitions of mobility, often linked to physical movement across borders, and the new realities of virtual student exchanges that allow for cross-cultural communication and knowledge sharing without the need for physical travel. With the backdrop of the policy pivot from the Japanese government for internationalization of education, the authors, based on student narratives, urge to re-frame discourse in policy circles and university spaces to "internationalization at home."

The next article investigates the use of AI-powered speech recognition technology to improve English pronunciation and speaking skills of EFL learners. By examining both the measurable impact on language skills and students' subjective experiences, this study provides valuable insights into the potential of AI-assisted language learning. Dennis situates the study within current debates around the role of AI in language acquisition and pedagogy with implications for language educators, curriculum designers, and developers.

Article six explores the timely topic of how first-year engineering students in The Philippines adjust academically and socially to hybrid learning environments in the post-pandemic era. As universities transition back to more in-person instruction while retaining some online components, understanding students' experiences with this new modality is crucial for supporting their success. Firmante uses a phenomenological approach to give primacy to student voices through focus groups, observations, and student essays. Although the hybrid modality seems inevitable for flexible and inclusive learning, the author, as a practicing school counsellor, highlights the need for universities to better structure hybrid programs and provide targeted support services to ease first-year students' transition.

The final article focuses on e-comic strips as a discursive technique for English language learning in virtual classrooms, specifically to enhance lexical competence. Flores-González, Flores, and Hernández describe their techno-pedagogical model mediated by three applications coupled with various individual and collaborative activities, designed for the experimental study. The authors assess the impact of their model based on standardised tests of lexical competency as well as student perceptions of how well the applications fulfil 18 criteria of Technique Feature Analysis. The study found that use of e-comics enhanced creativity,

language involvement, and confidence, facilitating a transition from memorization of word lists to extension of lexicon and application in different communicative contexts.

Overall, given the quality and diversity of articles, we hope you find them thought provoking and inspiring as we navigate the new realities of technology in education.

Devayani Tirthali, Associate Editor
Daniel L. Hoffman, Associate Editor, and
Michael P. Menchaca, Editor

IAFOR Journal of Education: Technology in Education
tech.editor.joe@iafor.org

Notes on Contributors

Article 1

Factors Influencing Teachers' Use of Artificial Intelligence for Instructional Purposes

Dr Mukhammadfoik Bakhadirov

Mukhammadfoik Bakhadirov is an Associate Professor at School of Business and Economics, Westminster International University in Tashkent, Uzbekistan. He is an experienced education professional with a demonstrated history of working in higher education in CIS countries. Mukhammadfoik Bakhadirov has been a lead for multiple programs in Business and Management at graduate and undergraduate levels, and managed projects relating to Entrepreneurship and SME development. Mukhammadfoik Bakhadirov obtained his terminal degree from Maastricht School of Management, Maastricht University, graduate degree from University of Westminster and undergraduate degree from Cairo University. The scope of his publications and research interests include SME, Entrepreneurship, Leadership, Management, Organizational Behavior, HR Management and Education.

Email: foiqxon@gmail.com

Dr Rena Alasgarova

Rena Alasgarova is the Deputy Academic Principal for Secondary School at Baku Oxford School, Azerbaijan. She is currently pursuing her second PhD at Charles University in Prague, where she investigates first language attrition in academic settings. Dr Alasgarova graduated from the Azerbaijan University of Languages with a BA in English Language Philology and subsequently earned her MA in TESOL and PhD in International Leadership from Horizons University, Paris. Throughout her career, she has received numerous international teaching diplomas and certificates and has presented at various educational conferences worldwide. Rena is also an active member of the twelfth European Digital Education Hub squad, which is focused on the exploration of explainable artificial intelligence in education.

Email: rena.alasgarova@bakuoxfordschool.net

Dr Jeyhun Rzayev

Jeyhun Rzayev is a cultural anthropologist with a historical background. He earned his bachelor's and master's degrees from Baku State University and completed his PhD in 2014. Currently, he is an Assistant Professor at ADA University in Baku, Azerbaijan, where he teaches the course "Civilizations and Cultures". Dr. Rzayev is deeply engaged in academic research, focusing on AI in educational settings. He is the author of two guidelines and 25 scientific articles, and co-author of four books. Additionally, Dr. Rzayev serves as a reviewer for the *IAFOR Journal of Education: Studies in Education* and *The International Journal of Technology in Education and Science*.

Email: jrzayev@ada.edu.az

Article 2

Perception of ChatGPT Usage for Homework Assignments: Students' and Professors' Perspectives

Dr Irena Miljkovic Krecar
Irena Miljkovic Krecar graduated in psychology, gained a master's degree in organizational psychology and a doctorate in psychology, all at Faculty of Humanities and Social Sciences in Zagreb. Since graduation, she has been working as personal counsellor and job selection professional, but mostly as a psychology lecturer and trainer. She is employed at the VERN' University as a psychology professor, teaching eight different courses. She has published over 30 scientific and expert articles, course books in business psychology and psychology of tourism and presented papers at many international conferences.
E-mail: irena.miljkovic@vern.hr

Dr Maja Kolega
Maja Kolega graduated in Psychology at the Faculty of Philosophy, completed postgraduate study, Supervision in psychosocial work and gained PhD at the Faculty of Law, University of Zagreb, Croatia. She is currently employed at VERN' University as a psychology lecturer, teaching and developing different courses. Her main interests are education and organizational development.
Email: maja.kolega@vern.hr

Dr Lana Jurcec
Lana Jurcec is an Associate Professor at the Faculty of Teacher Education. Her main research interest is in the fields of educational psychology and positive psychology. She published about twenty-five scientific papers, two book chapters and one professional book.
Email: lana.jurcec@ufzg.hr

Article 3

Developing a Course on Human-Centered Machine Learning-Based Product Design

Eui-Chul Jung
Seoul National University, South Korea
Email: jech@snu.ac.kr

Meile Le
Hanyang University, South Korea

Article 4

Internationalized Students: Examining Students' Experiences in Virtual Study Abroad Programs in Japan

Dr Ariunaa Enkhtur

Ariunaa Enkhtur (PhD) is a specially appointed assistant professor at the Center for Global Initiatives, Osaka University, Japan. Her research interests include internationalization of higher education, academic mobility, virtual student mobility, transnational higher education, international education and development, teaching and learning. For more information about Ariunaa Enkhtur and her research works, please visit: https://researchmap.jp/ariunaa_enkhtur.
Email: enkhtur.ariunaa.cgin@osaka-u.ac.jp

Dr Ming Li

Ming Li (PhD) is an Associate Professor at the Institute for Transdisciplinary Graduate Degree Programs, Osaka University, Japan. Her major academic fields include the internationalization of higher education, international student mobility, and interdisciplinary education. For more information about Dr. Ming Li and her research works, please visit:https://researchmap.jp/liming
Email: li.ming.itgp@osaka-u.ac.jp

Article 5

Using AI-Powered Speech Recognition Technology to Improve English Pronunciation and Speaking Skills

Dr Nutprapha K. Dennis

Nutprapha K. Dennis holds a PhD in English Language Studies from Suranaree University of Technology, Thailand, and MA in Teaching English as a Foreign Language (TEFL) from Ubon Ratchathani University, Thailand. She is currently a Senior English Lecturer at Ubon Ratchathani Rajabhat University, where she has over 15 years of experience teaching English at the university level. Her research interests include language teaching, material and course design, English communication in cross-cultural contexts, and educational technologies.
E-mail: nootprapa.k@ubru.ac.th

Article 6

Academic and Social Adjustment to Post-Pandemic Hybrid Learning: A Phenomenological Study of Filipino First-Year Engineering Students' Experiences

Maria Cristina M. Firmante

Maria Cristina M. Firmante is a registered guidance counselor with over 18 years of experience. She works as a University Counselor at De La Salle University. She completed a BS in Psychology, Master of Arts in Education, major in Guidance and Counseling, and is currently a candidate for a doctorate in Counseling Psychology, major in Clinical Counseling at De La Salle University. Cris has been a speaker at various seminars on guidance and counseling, mental health, and positive psychology. She is also passionate about research and has presented and published her work locally and internationally. She serves as a board member of the

Educational Counselors of the Asia-Pacific (ECPA-APECA, Philippines) and an active member of the Philippine Guidance and Counseling Association (PGCA, INC.).
Email: maria.cristina.firmante@dlsu.edu.ph

Article 7
The Influence of E-Comics on English Lexical Competence in Virtual Higher Education

Dr Norma Flores-González
Norma Flores-González is a professor-researcher at the Faculty of Languages of the Benemérita Universidad Autónoma de Puebla, Mexico. She has a degree in Modern Languages, a Master in Educational Sciences degree, and a PhD in Education. Her areas of interest are face-to-face, virtual, and distance education, evaluation, tutoring, and teaching practice. She has presented papers and research in national and international contexts and published in national and international journals. She belongs to the National System of Researchers (SNI).
Email: norma-fg@hotmail.com

Dr Vianey Castelán Flores
Vianey Castelán Flores is a professor-researcher of the French Teaching Bachelor at the Benemérita Universidad Autónoma Puebla. She has a degree in Modern Languages, a Master in Education degree, and a PhD in Education. She is a Coordinator of Academic Evaluation and the Scholarships Department. Her areas of interest are teaching, research, and evaluation.
Email: fcvianey@hotmail.com

Dr Mónica Zamora Hernández
Mónica Zamora Hernández is a research professor of the French-Teaching Bachelor at the Faculty of Languages of the Benemérita Universidad Autónoma de Puebla. She has a degree in Modern Languages, a Master in Educational Sciences degree, and a PhD in Education. Her field of study is tutoring and teaching-learning processes of foreign languages.
Email: monica_zahdz@gmail.com

Factors Influencing Teachers' Use of Artificial Intelligence for Instructional Purposes

Mukhammadfoik Bakhadirov
Westminster International University, Uzbekistan

Rena Alasgarova
Baku Oxford School, Azerbaijan

Jeyhun Rzayev
ADA University, Azerbaijan

Abstract

The current paper examined the impact of a set of individual, technological, and institutional variables on the adoption of artificial intelligence (AI) among teachers at private schools. The rationale for this study lies in its contribution to the understanding of how teacher characteristics, institutional support, and technological perceptions affect AI adoption in educational settings. The study used data collected from teachers (*n*=306) from seven schools located in Azerbaijan in 2024. The study suggested that perceived usefulness of AI increases teachers' use of AI for educational purposes, while perceived ease of use of AI has no statistically significant impact. The study also documented a statistically significant link between institutional policy and the use of AI by colleagues on the one hand, and AI adoption among schoolteachers on the other. Finally, the study found evidence relating to the link between AI adoption and the age of the teacher, such that teachers who are younger were more likely to adopt this technology. Surprisingly, personal innovativeness and level of openness to new experiences did not stimulate teachers to adopt AI for teaching. The findings contribute to improving the field's understanding of teachers' attitudes and motivations for using AI for instructional purposes. The study findings also highlight the role of administrative regulation and school policies in stimulating the adoption of new technologies. These findings contribute to relatively novel literature relating to the application of AI in education and provide useful recommendations for administrators of educational institutions.

Keywords: artificial intelligence, education, personality, technology acceptance, technology adoption innovativeness

Whilst the rapid advancement of technology continues to change the educational landscape, artificial intelligence (AI) is becoming a major influence on the methods and outcomes of education. The introduction of AI in teaching and learning processes presents numerous opportunities for improving efficiency in content delivery; however, AI should be implemented based on consideration of both technological and human aspects. The Technology Acceptance Model (TAM), designed by Davis (1986), provides an effective model for predicting the extent to which technology is accepted by educators. This model envisions perceived usefulness and perceived ease of use as key components influencing technology acceptability, which are particularly relevant when discussing the incorporation of AI in education (Davis & Granić, 2024).

The acceptability and application of AI in educational contexts are influenced by personality qualities articulated in the Big 5 model (Kaya et al., 2022; Sánchez-Prieto et al., 2019; Seibert et al., 2021; Sindermann et al., 2022; Stein et al., 2024). The Big 5 model categorizes personality traits into five broad dimensions: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. These attributes define how a person would react to change and new technologies, and, therefore, how they would approach AI tools when the latter are introduced into their teaching environment. According to Kaya and colleagues (2022), characteristics such as openness to experience and conscientiousness can have a substantial impact on a teacher's readiness to incorporate new technologies, such as AI, into their teaching practices. These characteristics influence how educators see the potential benefits and usefulness of AI tools, determining their readiness to adopt such technologies. The Big 5 traits provide comprehensive knowledge of the psychological aspects that might support or hinder technological transition in education, meaning that individual personality differences must be considered when devising targeted interventions to boost AI adoption (Stein et al., 2024). This psychological preparedness is vital since it complements the practical needs and pressures that educators face in their professional orientation.

In the context of education, teacher burnout has persisted as a major issue affecting teachers in the course of time and poses several implications for their willingness to accept and incorporate technological teaching aids into their teaching process (Sindermann et al., 2022). Researchers argue that teachers often work under pressure and stress originated from administrative tasks, as well as the urge to address students' individual learning needs, which can be aggravated by limited administrative support systems (Arvidsson et al., 2019). These practices can result in a high level of stress and burnout among teachers, therefore inhibiting their ability to perform effectively and foster a positive and constructive learning atmosphere. AI technologies may help reduce some of these stressors due to the adoption of new technologies and automation of processes which would improve the experience and work satisfaction of teachers, thereby promoting job retention, improved quality of teaching, and improved outcomes for students (Haleem et al., 2022). For instance, AI can aid in effective performance and individual assessments, thus minimizing the amount of work in this area of teachers' day-to-day activities and helping them focus on the teaching process and its effectiveness.

Thus, schools should prioritize the development of clear policies and support frameworks that address the technical and pedagogical aspects of AI integration (Ding et al., 2024; Karakose & Tulubas, 2024). In turn, by creating conditions for positive attitudes towards and usage of technologies in general and AI in particular, school leaders and administrators may enhance teachers' professional practice and expertise, hence, improving their students' outcomes.

The need to integrate these technological innovations in educational settings underlines the urge for proper policies at schools regarding the application of the technologies. Such a proactive approach will address several of the previously discussed concerns surrounding how AI can potentially reduce the workload in teaching without ever coming to fruition in practice for many teachers. For any policy to be effective, it should not only encapsulate the resolution of compatibility problems but also ensure that AI implementations are in line with education goals and aims, as well as consider teachers' needs to enable a harmonized adoption of AI to boost the teaching and learning environment (Fullan et al., 2023; Chan, 2023). This study aims to explore a range of factors affecting AI use in teaching. It does this by addressing the following research questions:

1. What is the impact of the perceived usefulness of AI technology on its adoption among teachers?
2. How does perceived ease of use influence teachers' willingness to employ AI tools in their instruction?
3. What role does teachers' innovativeness play in the acceptance and integration of AI into teaching?
4. How does openness to new experiences influence teachers' attitudes towards and engagement with AI technologies?
5. What influence do school policies have on the adoption and effective use of AI by teachers?

The significance of this research is underscored by the comprehensive analysis provided by the European Digital Education Hub's briefing reports (Le Borgne et al., 2024; Obae et al., 2024). These reports elaborate on the necessity of equipping educators with AI literacy and adapting curricula to include AI competencies as integral components of modern education. Specifically, Briefing Report 1 highlights the urgency of continuous professional development that addresses both the technological and pedagogical aspects of AI integration, ensuring that teachers are not only users but also informed implementers of AI technologies in their classrooms (Le Borgne et al., 2024). Briefing Report 4 discusses the crucial role of institutional support systems in facilitating the effective use of AI within educational frameworks. It emphasizes the importance of school policies that are flexible yet robust enough to support the dynamic nature of AI technologies, advocating for policies that can solve compatibility issues and foster an environment conducive to technological advancements and teacher acceptance (Obae et al., 2024).

The current study expands upon these premises by considering a wider range of factors affecting AI use in teaching, including teachers' traits like innovativeness and willingness to

experiment, characteristics of the learning environment, policies, and administrative support. By discussing these dimensions, this study attempted to create a bigger picture of the role that different factors are playing in the process of adopting new AI technologies in education. Thereby, it offers valuable insights for administrators and policymakers aiming to foster a more effective integration of AI in schools.

The remainder of the paper is structured as follows. 'Literature Review' develops the hypotheses. 'Data and Methodology' describes the methods of the study and data collection procedures. 'Results' presents the findings of the analysis. 'Discussion' describes the findings of the study, its theoretical and practical implications. The paper concludes with 'Conclusions and Recommendations'.

Literature Review and Hypothesis Development

Technology Adoption and the Use of AI in Education: The Role of Perceived Usefulness and Perceived Ease of Use

Introduced by Davis in 1986, TAM is a framework that provides a strong foundation for studying the adoption of technology in the educational landscape. This model revolves around two principal concepts that determine the attitude of educators towards accepting new technologies: perceived usefulness and perceived ease of use (Davis & Granić, 2024). In the context of AI for education, these constructs guide the evaluation of educators' judgments about what aid AI tools can bring and how they fit into current pedagogical practices (Kelly et al., 2023).

The perceived usefulness of AI in education is said to be connected to its capacity to revolutionize the pedagogical context. AI technologies, which are viewed as "an auxiliary system for education" (Uygun, 2024, p. 938), allow the education process to get more personal and optimal for achieving the utmost learning outcomes and providing space for adaptation to the individual psychological needs of students as related to "their autonomy, competence and social relatedness" (Ofosu-Ampong et al., 2023, p. 45). This also relates to the personalization of activities to reflect the specific pace and style of learning, as well as tailoring relevant constructive feedback and assessment that considers the strengths and weaknesses of individual students. It is argued that the qualities of AI, which directly support learning and teaching processes in improving student outcomes and developing "their creative ability to shape their thoughts", are useful for facilitating a more dynamic and interactive classroom environment (García-Martínez et al., 2023, p.188). Additionally, the ability of AI to reduce the amount of time spent on administrative workload related to tasks like grading or evaluating students' assignments is beneficial to the educator as it increases the amount of time that the educator spends on teaching and interacting with the student (Owan et al., 2023). The cumulative effect of these AI applications can help teachers ensure a challenging, however engaging, and positive learning environment in which both teachers and students can thrive. Through reducing burdens and enriching a positive teaching experience, AI can promote more sustainable and satisfying teaching practices.

The above arguments suggest that the perceived usefulness of AI motivates teachers to improve their teaching practices by introducing AI into the educational process. Therefore, we hypothesize that:

Hypothesis 1: *a. Perceived usefulness of AI stimulates the use of AI for educational purposes*

Teacher burnout is a challenging issue in today's educational settings and is a condition of physical, emotional, and mental exhaustion that leads to negative and sometimes inappropriate responses towards students, their jobs, and colleagues in general. This occurs due to the myriad of demands that fall on teachers, which include but are not limited to administrative paperwork, constant assessment and evaluation of students' assignments, and the efforts to accommodate diverse learning types and preferences (Arvidsson et al., 2019). The increased emphasis on technology and especially on the use of AI provides the space for diminishing, or at least preventing, some of these stressors through the automation of menial tasks and simplifying complicated work processes, thus eliminating the risk of burnout (Bauwens et al., 2020). This supports the claim that AI not only empowers teaching practices but also enhances teachers' job satisfaction and their career sustainability within the teaching field. In this context, the transformation implies the introduction of AI in education by simplifying tasks and reducing workload, which naturally leads to the concept of perceived ease of use of the TAM framework, emphasizing the necessity of creating AI tools that are simple and easily adapted into the educational system.

Perceived ease of use represents the idea that teachers consider learning to use AI in their classroom practices to require minimal effort. Teachers can be more inclined to accept tools that they can easily understand or that do not require sophisticated technical skills and are compatible with the existent educational frameworks (Al Darayseh, 2023; Ofosu-Ampong, 2024). The lack of integration and noticeable gaps in how these technologies align with daily teaching activities are crucial factors in teachers' low acceptance of AI tools. The above arguments suggest that teachers are more interested in adopting AI for teaching purposes when their perception of its ease of use is high. Therefore, we hypothesize that:

Hypothesis 1: *b. Perceived ease of use of AI stimulates the use of AI for educational purposes.*

Acceptance of the AI by Teachers: The Role of Personality and Individual Factors

The adoption of AI in educational environments is largely determined by personal characteristics (Kaya et al., 2022; Sánchez-Prieto et al., 2019; Sindermann et al., 2022). Historical shifts in education types, for example, the introduction of the internet, the rise of edtech, and the rapid pivot to online learning during COVID-19, have revealed differences in the degree of adaptability among educators (Haleem et al., 2022; Ng et al., 2023). These transformations show that some educators approach and master new technologies with ease, whilst others still have some hesitation due to their risk averse or conservative nature. Such

fluctuations in adaptation can be envisaged through the lens of the Big 5 personality dimensions. For instance, openness to experience encompasses such traits as curiosity and a predisposition to explore new things, which relates to teachers' innovativeness (Bauwens et al., 2020). Those who are high in this trait are more likely to incorporate AI technologies into their teaching practices since they are more open to change, possibly leading to more improved and efficient teaching experiences in schools.

Empirical research studies emphasize individual differences in technology adoption. Teachers with high levels of openness and innovativeness are the ones who usually experiment with new tools and are most successful in integrating these platforms into their teaching practices. As stated by Kaya and colleagues (2022) "openness to experience may increase the perceived practicality and ease of use of technology" (p. 508). Innovativeness in education is not only about technology but also about creativity in pedagogy and curriculum design that determines the direction of the evolution of educational practices (Seibert, et al., 2021).

In ever-evolving education, with advancements in technology, the importance of such personality characteristics as innovativeness in technology acceptance needs to be appreciated (Haleem et al., 2022; Sánchez-Prieto et al., 2019). This individual orientation is useful not only in understanding why some educators are better at technology-enhanced learning but also in providing a more finely tuned view of technology integration in the educational world. Therefore, we suggest that:

Hypothesis 2: *a. Teacher's innovativeness is positively associated with the adoption of AI for teaching purposes.*

In examining the nature of technology adoption by educators, the Big 5 personality model, particularly the trait of openness to experiences, is rather revealing (Kaya et al., 2022; Stein et al., 2024). This characteristic encompasses the person's inclination towards innovation and their open-mindedness to the demonstration of fresh concepts and strategies that reflect their readiness to assimilate and apply AI tools in their teaching practice. (Sánchez-Prieto et al., 2019).

A high level of openness in teachers highlights their curiosity, imagination, and being broadly keen on incorporating technologies into their pedagogical repertoire (Kaya et al., 2022; Sánchez-Prieto et al., 2019; Sindermann et al., 2022). Teachers, high in openness, are often the early adopters of new technologies who explore their potential to improve learning and teaching outcomes with much more enthusiasm than their less open colleagues. The correlation of openness to technology adoption is backed by recent empirical studies indicating that the teacher's personality traits play a significant role in the process of technology integration into classrooms. One of the examples is that educational professionals with a high degree of openness are not only quick to try out new tools but are also experts in incorporating these innovations in ways that promote student engagement and outcomes (Sánchez-Prieto et al., 2019).

The openness of teachers to new experiences allows for the customization of professional development programs. Such professional development programs should be developed to cater for the needs and wants of teachers regardless of their inherent passion for new technologies and to ensure a more effective and inclusive adoption of educational innovations.

Apart from openness, the Big 5 model incorporates other personality traits such as conscientiousness, extraversion, agreeableness, and neuroticism. The conjunction of these characteristics creates a complex image of the person that influences his or her conduct in various areas of life, including professional activities (Seibert et al., 2021). Comprehending these personality-driven aspects can help in implementing focused plans for technology integration in schools. Therefore, we hypothesize that:

Hypothesis 2: *b. Teacher's openness to new experience is positively associated with the adoption of AI for teaching purposes.*

AI Adoption and Institutional Policies: The Role of Administrative Support

The incorporation of AI into educational settings is not a mere technological innovation but an involving process that needs strong administrative support. The adoption landscape of educational technology is quite diverse, with some schools being pioneer adopters of innovative tools and methods, while others are conservative and diligent, often slowing down the technological spirit. Such differences are mostly caused by the various levels of support and promotion that educational institutions offer (Chan, 2023; Rahman & Watanobe, 2023).

Schools that are inclined to promote the implementation of innovative technologies are generally progressive organizations that consider technological innovation as a fundamental tool to improve educational outcomes. These schools invest not only in the equipment and software needed but also in a culture of continuous learning and adaptability (Fullan et al., 2023; Karakose & Tulubas, 2024). Support services in these schools include continued professional development designed to help teachers integrate new technologies effectively into their pedagogy.

On the other hand, the difficulty that schools face in implementing technology is largely due to a lack of institutional support. Under these conditions, teachers become isolated in their attempt to introduce new tools and unsure of the possible consequences of failures (Sindermann et al., 2022). Fear of failure is a detrimental factor in educational settings where innovation does not have institutional recognition. Teachers in such environments are usually unwilling to stray from the accepted norms and practices owing to job security fears, criticism, and a lack of benefit from changing their teaching styles (Roczniewska et al., 2020).

Administrative support profoundly affects this by creating an environment in which technology experiments are viewed more as learning experiences than as a threat. As long as school leaders endorse the use of AI and other technologies as part of the school vision aimed at providing

future-ready education, it creates a setting that can erase fears and excite the staff (Fullan et al., 2023; Karakose & Tulubas, 2024).

However, this supportive orientation should also entail the provision of needed infrastructure – reliable internet access, up-to-date computing equipment, and technical support – that will make the adoption of new technologies a possibility and a less intimidating process for an educator. "This attempt not only requires enabling a more digitally enhanced learning environment but also integrating these technologies to practice effective management and leadership in contemporary schools" (Karakose & Tulubas, 2024). The implementation of AI technologies into teaching and learning environments demands "school leaders to constantly adapt and expand their technological knowledge and skills simply to remain ahead of the AI curve" (Fullan et al., 2023, p. 4). Additionally, incentives and reward systems that recognize innovative teaching related practices, can motivate teachers to experiment with and embrace the use of new technologies.

Such policies help educators understand how AI tools should be integrated into the learning process and how these tools can bring about better learning outcomes among students. Clear policies aid in creating the yardsticks for success and a framework within which teachers may innovate with confidence. Administrative assistance also provides continued support through training programs that enable educators to keep up to date with technological advancements and pedagogical strategies that utilize these technologies appropriately (Bauwens et al., 2020; Ding et al., 2024; Sindermann et al., 2022). For successful AI adoption, teachers should be taught not only how to use new tools but also why these tools will improve their students' educational experiences and outcomes. Therefore, we claim that:

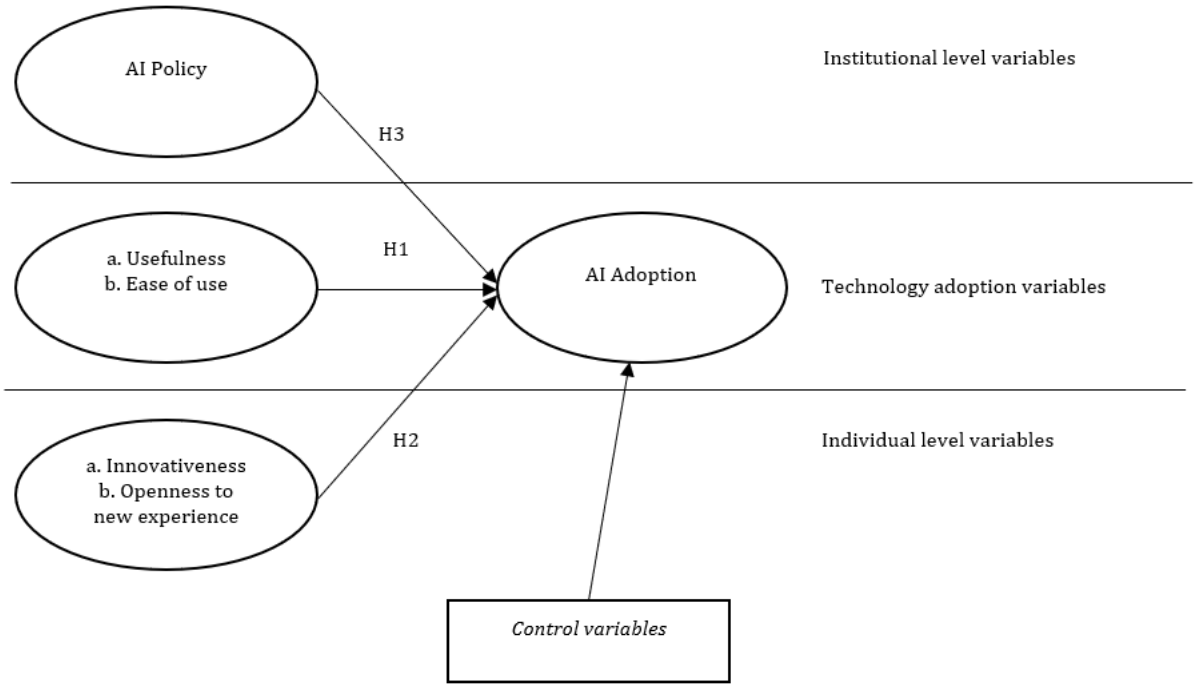
Hypothesis 3: *Presence of school policy supporting the use of AI increases the use of AI for teaching purposes.*

Conceptual Model

A review of the existing literature on the application of AI technology in education has identified a considerable gap for further investigation. Our study aims to contribute to this examination, particularly in relation to the sets of (H1) technology adoption factors (i.e., perceived usefulness and perceived ease of use), (H2) personality and individual variables (i.e., innovativeness and openness to new experiences), and (H3) institutional support (the school's AI policies). A conceptual model of the proposed study is presented in the following page.

Figure 1

Conceptual Model of the Study



Data and Methodology

Data and Its Collection

The study utilized a survey methodology, collecting data from teachers working at the seven largest private schools in Baku, Azerbaijan. The study's questionnaire was piloted among 12 teachers to improve its face and content validity. Then, anonymized copies of the questionnaire were distributed among all secondary teachers. The population of the study encompassed 956 teachers. The response rate comprised 32% with 310 teachers voluntarily agreeing to participate in the study. Four questionnaires were removed from the pool as they failed to answer the attention check questions correctly. Responses collected from 306 teachers constituted the dataset. Table 1 summarizes the descriptive statistics for the study sample. Ethical issues were closely followed throughout the investigation in accordance with APA 7 principles. Every participant received comprehensive details regarding the research, guarantees of their privacy and confidentiality, and knowledge of their freedom to discontinue participation at any moment without repercussions (American Psychological Association, 2017).

To further ensure the validity of the data, the following measures have been taken. Several Likert scale items have been reversed. A reliability test was conducted to measure the internal consistency of the collected data. Moreover, a factor analysis was performed to estimate whether the variables heavily loaded around a common factor.

Table 1
Descriptive Statistics (n=306)

Variable	Range	Min	Max	Mean	SD
Gender of the respondent (GEN)	1	1	2	1.58	0.49
Age of the respondent (in full years) (AGE)	46	21	67	37.56	8.79
Highest education level (STAG)	2	1	3	1.98	0.645
Level of computer proficiency/skills (COM)	2	1	3	2.76	0.44
School policy that supports the use of AI (POL)	1	0.00	1	0.31	0.46
Use of AI by a colleague(s) (CUSE)	1	0.00	1	0.73	0.45
Use of AI by the respondent (USE)	1	0.00	1	0.57	0.5
Perceived usefulness (PU)	17	4	21	17.97	3.05
Perceived ease of use (PEU)	21	7	28	24.03	3.36
Attitude toward AI (ATT)	8	6	14	11.56	1.92
Internal Locus of Control (ILC)	7	8	15	11.60	1.44
Innovativeness (INN)	17	18	35	29.34	4.04
Hope	11	10	21	18.63	1.93
Optimism	11	10	21	19.25	1.58
Self-efficacy	9	12	21	19.06	1.52
Resilience	11	10	21	17.81	2.75
Openness (OP)	9	19	28	25.67	1.75
Psychological Capital (PSYCAP)	42	42	84	74.75	5.98

Note. The table documents the descriptive statistics for the variables used in this paper. All variables are discussed in section 3.2. The sample period is from April to May 2024.

Measurement and Analysis

The purpose of the study was to measure the impact of individual, institutional, and technological factors on the use of AI in educational ecosystems as posed in our main research question. Specifically, it was hypothesized that the adoption of AI technology is stimulated by (H1) the components of the technology adoption, i.e., perceived usefulness and the perceived ease of use of AI technology, (H2) the presence of an AI support policy, and (H3) individual-level variables such as openness to new experiences, innovativeness. The ordinary least squares regression equation presented below was employed to test these hypotheses.

$$\begin{aligned} \mathrm{USE} = {} & \alpha + \beta_1(\mathrm{PU}) + \beta_2(\mathrm{PEU}) + \beta_3(\mathrm{POL}) + \beta_4(\mathrm{OP}) + \beta_5(\mathrm{INN}) + \beta_6(\mathrm{SCHL}) \\ & + \beta_7(\mathrm{AGE}) + \beta_8(\mathrm{GEN}) + \beta_9(\mathrm{SUBJ}) + \beta_{10}(\mathrm{STAG}) + \beta_{11}(\mathrm{CUSE}) \\ & + \beta_{12}(\mathrm{COM}) + \beta_{13}(\mathrm{ATT}) + \beta_{14}(\mathrm{ILC}) + \beta_{15}(\mathrm{PSYCAP}) + \varepsilon \end{aligned} \quad (1)$$

In the above regression equation, the dependent variable USE represents the use of artificial intelligence technology usage by teacher for educational purposes. For (H1), we used a PU variable to measure the degree of usefulness of AI and a PEU variable to measure the degree of ease of use of AI as perceived by teachers. For (H2), we used an INN variable to measure the degree of innovativeness and an OP variable to measure the openness to new experiences

by schoolteachers. For (H3), we used a POL variable to measure whether schools have policies supporting the use of AI for teaching and learning purposes in place.

- PU – perceived usefulness factor – component of TAM (Davis, 1989). It is suggested that perceived usefulness, which can be defined as a person's perception of the degree to which technology use can improve performance, should stimulate the use of AI technology. This factor is generated using the principal component analysis and calculated as a sum of answers to three out of four 7-degree Likert scale items e.g. *I would find AI technology useful in my work.* One item was dropped as a result of the reliability test, and the calculated Cronbach's alpha for perceived usefulness was equal to 0.832.
- PEU – perceived ease of use factor – another component of the technology acceptance model (TAM) measures P the level to which a person believes that using a particular system is free of effort (Davis, 1989). This construct originates from the concept of self-efficacy, which pertains to an individual's specific belief in their ability to successfully perform actions required for a future task. Similar to perceived usefulness, a higher degree of perceived ease of use should also lead to a higher likelihood of adopting AI technology according to the TAM model. The 7-degree Likert scale items, such as *I would find it easy to get AI technology to do what I want to do* was used to measure PEU. The latent variable was generated using the principal component analysis from four 7-degree Likert scales items. The calculated Cronbach's alpha for PEU scale is equal to 0.795.
- INN – innovativeness variable was measured using an adopted scale by De Jong and Den Hartog (2008). It contained 7-degree Likert scale items such as *I systematically introduce innovative ideas into work practices*. These were grouped into a single latent variable using the principal components analysis and calculated as a sum of five variables. Cronbach's alpha for this factor is equal to 0.812.
- OP – openness to new experience variable measured using the Big 5 Personality traits scale items. It included eight regular and two reversed 7-degree Likert scale items, such as *I see myself as someone who is curious about many different things.* These were grouped into a single Openness laten variable using the sum of four variables that were grouped around the common factor as a result of principal component analysis. Reliability analysis
- The other independent variable of interest is POL. It is a dummy variable measuring the school's support for the use of AI at a policy level, where 1=represents the presence of policy and 0=absence of school policy supporting the use of AI.

The differences across the schools were taken into account by controlling for the school (SCHL) variable. Moreover, the above regression equation also contains multiple personality and individual-level characteristics as control variables. These are:

- AGE – age of the respondent,
- GEN – gender of the respondent,

- SUBJ – subject teachers teach,
- STAG – stage of education,
- COM – degree of computer proficiency,
- ATT – general attitude toward artificial intelligence,
- PSYCAP – psychological capital of a teacher (calculated as a sum of for items: hope, optimism, self-efficacy, and resilience), and
- ILC – locus of control, which stands for the perceived degree of control over the things happening in one's life, including success and failure.
- Finally, we also believe that teachers are more likely to adopt AI should their work colleagues use AI for teaching purposes on a regular basis and measure it using the CUSE dummy variable where 1=colleague(s) are using AI for instructional purposes and 0=otherwise.

Results

Results of the Regression Analysis

Table 2 displays the correlations between the independent variables. The modest correlation between these variables suggests that the analysis is not subject to a problem of multicollinearity.

Main regression analysis results are presented in Table 3. As anticipated, statistically significant positive estimates are documented for multiple variables of interest. First, in relation to Hypothesis 1 (H1), the perceived usefulness of AI technology is found to be statistically very significant, suggesting that teachers who view AI as a beneficial tool are more likely to incorporate it into their teaching. Perceived ease of use of AI is found to be significant only at *p*-value=0.1 level. Concerning Hypothesis 2 (H2), teacher innovativeness was found to be a significant predictor of AI adoption, confirming the hypothesis that more innovative teachers are inclined to use AI in their educational practices. Contrary to expectations, openness to new experiences did not significantly influence AI adoption, indicating that teachers will use AI regardless of their degree of openness to new experiences. For Hypothesis 3 (H3), the presence of a school AI policy was significantly associated with AI usage, underscoring that the school that have AI policies in place better stimulate the use of AI for educational purposes by teachers. Additionally, the study suggests that adoption of AI among the teachers is also (i) negatively related to their age (younger teachers are more likely to use AI), and (ii) positively related to the use of AI technology by their colleagues.

Table 2

Correlation Matrix

No.	Variables	1	2	3	4	5	6	7	8
1	Use Of AI	1.000							
2	Perceived Usefulness	.262	1.000						
3	Perceived Ease of Use	.158	.717	1.000					
4	School Policy	.194	.165	.038	1.000				
5	Openness	.071	.188	.200	.112	1.000			
6	Innovativeness	.160	.147	.219	.076	.271	1.000		
7	School	-.092	.084	.041	-.073	.196	.024	1.000	
8	Gender	-.009	.158	.146	-.034	.026	.047	-.105	1.000
9	Age	-.135	.066	-.016	.072	.152	.016	.059	-.119
10	Teaching Area	-.082	-.224	-.145	-.138	-.102	-.083	.051	-.046
11	Stage	.061	.178	.201	.033	-.101	.098	-.197	.071
12	Computer Skills	.061	.079	.008	.124	.088	-.162	-.028	.012
13	AI Use by a Colleague	.270	.213	.223	.151	-.047	-.009	-.160	.060
14	Attitude Toward AI	.080	.294	.163	-.025	.259	.318	.225	-.040
15	Locus Of Control	.095	.024	.043	-.053	.151	.139	.023	-.032
16	Psychological Capital	.081	.225	.202	.050	.640	.279	.428	-.049

(cont.)

No.	Variables	9	10	11	12	13	14	15	16
1	Use Of AI								
2	Perceived Usefulness								
3	Perceived Ease of Use								
4	School Policy								
5	Openness								
6	Innovativeness								
7	School								
8	Gender								
9	Age	1.000							
10	Teaching Area	-.066	1.000						
11	Stage	-.040	-.018	1.000					
12	Computer Skills	.001	.004	-.097	1.000				
13	AI Use by a Colleague	.014	-.193	.066	.148	1.000			
14	Attitude Toward AI	.031	-.086	.086	-.102	-.059	1.000		
15	Locus Of Control	-.035	.013	.003	-.042	.021	.114	1.000	
16	Psychological Capital	.177	-.092	-.092	.069	-.003	.373	.270	1.000

Note. The table documents the correlation between variables used in this paper. All variables are as discussed in section 3.2. The sample period is from April to May 2024.

Table 3

Relationship Between the use of AI by Teacher, Individual-level Factors, Technology Acceptance Components, and Institutional Policies

Variables	Model (1)	Model (2)	Model (3)
Perceived Usefulness	0.269***	0.313***	0.304***
	(3.360)	(3.845)	(3.660)
Perceived Ease of Use	-0.065	-0.091	-0.136*
	(-0.812)	(-1.141)	(-1.705)
School Policy	0.144**	0.130**	0.111**
	(2.57)	(2.305)	(1.993)
Openness	-0.017	0.026	0.018
	(-0.302)	(0.442)	(0.254)
Innovativeness	0.129**	0.133**	0.130**
	(2.232)	(2.291)	(2.191)
School		-0.113**	-0.095
		(-1.982)	(-1.538)
Gender		-0.80	-0.079
		(-1.444)	(-1.443)
Age		-0.176***	-0.181***
		(-3.189)	(-3.323)
Teaching Area		-0.004	0.027
		(-0.066)	(0.491)
Stage		-0.011	-0.008
		(-0.187)	(-0.142)
Computer Skills		0.037	0.007
		(0.660)	(0.123)
Ai Use by a Colleague			0.216***
			(3.780)
Attitude Toward AI			-0.014
			(-0.227)
Locus Of Control			0.057
			(1.021)
Psychological Capital			0.047
			(0.585)
(Constant)	-0.371	-0.216	-0.556
	(-0.878)	(-0.454)	(-1.124)
Observations	306	306	306
F-Value	7.214	4.812	4.825
R-Square	0.107	0.153	0.200

Note. This table documents the relationship between the use of AI by teacher, individual-level factors, technology acceptance components, and institutional policies. The t-values based on the heteroscedasticity-robust standard errors are presented in parentheses. The outcome variable is USE (the use of AI technology for teaching purposes). The sample period is April to May 2024. OLS regression model is used. The symbols ∗, ∗∗, ∗∗∗ correspond to $p < 0.1$, $p < 0.05$, $p < 0.01$, respectively. All variables are as defined in the 'Measurement and Analysis' section.

Additional Test

To examine the robustness of our results, the model was re-estimated by using an alternative proxy for the USE variable. The regression analysis was run to measure the impact of examined predictors on the Intention to use AI tech – INT as indicated in equation 2.

$$\begin{aligned} \mathrm{INT} = \alpha &+ \beta_1(\mathrm{PU}) + \beta_2(\mathrm{PEU}) + \beta_3(\mathrm{POL}) + \beta_4(\mathrm{OP}) + \beta_5(\mathrm{INN}) + \beta_6(\mathrm{SCHL}) \\ &+ \beta_7(\mathrm{AGE}) + \beta_8(\mathrm{GEN}) + \beta_9(\mathrm{SUBJ}) + \beta_{10}(\mathrm{STAG}) + \beta_{11}(\mathrm{CUSE}) \\ &+ \beta_{12}(\mathrm{COM}) + \beta_{13}(\mathrm{ATT}) + \beta_{14}(\mathrm{ILC}) + \beta_{15}(\mathrm{PSYCAP}) + \varepsilon \end{aligned} \quad (2)$$

Results of the alternative regression analysis were consistent with the previous findings with regards to the impact of the perceived usefulness. All three models suggested statistically very significant impact of perceived usefulness of AI on teachers' intention to use it for educational purposes. Similar to the previous model, the impact of colleagues' practices on the intention to use AI remains statistically significant whereas the individua-level variables, and institutional factors did not sustain their predictive value (Table 4).

The summary of this analysis is summarized in Table 5. As can be seen, all hypotheses except for H2b are supported according to the results of Test 1 and only H1a found support based on the results of Test 2.

Table 4

Relationship Between the Intention to Use AI by Teacher, Individual-Level Factors, Technology Acceptance Components, and Institutional Policies

Variables	Model (1)	Model (2)	Model (3)
Perceived Usefulness	0.310***	.330***	0.351***
	(3.868)	(3.982)	(4.098)
Perceived Ease of Use	-0.072	-0.062	-0.110
	(-0.900)	(-0.760)	(-1.331)
School Policy	0.089	0.090	0.069
	(1.579)	(1.582)	(1.209)
Openness	0.067	0.051	0.040
	(1.155)	0.845	(0.545)
Innovativeness	0.042	0.061	0.075
	(0.723)	(1.034)	(1.230)
School		0.038	0.050
		(0.654)	(0.777)
Gender		-0.072	-0.077
		(-1.276)	(-1.366)
Age		-0.059	-0.070
		(-1.058)	(-1.242)
Teaching Area		0.032	0.053
		(0.561)	(0.934)
Stage		-0.067	-0.059
		(-1.157)	(-1.020)
Computer Skills		0.048	0.019
		(0.850)	(0.331)

AI Use by a Colleague			0.148**
			(2.523)
Attitude Toward AI			-0.087
			(-1.357)
Locus Of Control			0.018
			(0.316)
Psychological Capital			0.074
			(0.883)
(Constant)	-0.353	-0.297	-0.438
	(-0.979)	(-0.719)	(-1.009)
Observations	306	306	306
F-Value	6.939	3.721	3.428
R-Square	0.104	0.122	0.151

Note. This table documents the relationship between the intention to use AI by teacher, individual-level factors, technology acceptance components, and institutional policies. The t-values based on the heteroscedasticity-robust standard errors are presented in parentheses. The outcome variable is USE (the use of AI technology for teaching purposes). The sample period is April to May 2024. OLS regression model is used. The symbols ∗, ∗∗, ∗∗∗ correspond to $p < 0.1$, $p < 0.05$, $p < 0.01$, respectively. All variables are as defined in the 'Measurement and Analysis' section**.**

Table 5

Summary of the Analysis Results

#	Hypothesis	Test 1 Results	Test 2 Results
1	a. Perceived usefulness of AI stimulates the use of AI for educational purposes	Supported***	Supported***
	b. Perceived ease of use of AI stimulates the use of AI for educational purposes	Supported*	Not supported
2	a. Teacher's innovativeness is positively associated with the adoption of AI for teaching purposes.	Supported**	Not supported
	b. Teacher's openness to new experience is positively associated with the adoption of AI for teaching purposes.	Not supported	Not supported
3	Presence of school policy supporting the use of AI increases the use of AI for teaching purposes.	Supported**	Not supported

Note. The symbols ∗, ∗∗, ∗∗∗ correspond to $p < 0.1$, $p < 0.05$, $p < 0.01$, respectively. All variables are as defined in the 'Measurement and Analysis' section.

Discussion

This research centers on examining the impact of individual, technological, and institutional factors on the use of AI for instructional purposes. Through an examination of these factors and their impact on the adoption of AI by instructors in private schools in Azerbaijan, the study finds important components that either help or impede the real-world implementation of AI technology in education.

The results of the current research posit perceived usefulness and supportive institutional policies as key factors influencing the incorporation of AI technologies into learning environments. According to recent studies, the perceived usefulness of AI plays a major role in adopting these tools in academic settings. This implies that the more the teachers understand the benefits of AI regarding improving teaching efficiency and students' performance, the more likely they are to incorporate the technologies in their teaching practice (Kelly et al., 2023). School policies are also a significant factor in the implementation of AI in classrooms. Schools need to develop clear policies and framework support for AI integration so that teachers feel more secure about using novice technologies and avoid rejection of AI tools (Chan, 2023; Fullan et al., 2023). These findings shed light on the importance of teachers, heads of schools, and other educational managers to support innovative approaches, which include leveraging AI teaching methods.

Another important factor that impacts the use of AI is peer influence: teachers are more likely to use AI if they observe other teachers using it. This peer effect highlights the need for developing a community of practice where innovative teachers and their colleagues can learn from each other and inspire others to test the advantages of AI (Sánchez-Prieto et al., 2019; Stein et al., 2024). Thus, school leaders should ensure that they support and encourage the early adopters of AI to prompt further development of the technology in their schools. These findings have theoretical and practical implications for the use of AI in an educational landscape, suggesting that understanding the integration of these technologies requires consideration of pertinent school polices, teachers' perceptions, and educational contexts.

The significance of this study lies in its contribution to a deeper understanding of the way the institutional support, technology capabilities, and teacher traits interact to enable the adoption of AI in educational ecosystems. Through the identification of the critical roles of perceived utility, policy support, and peer influence, the study offers practical insights that might assist educational institutions in formulating policies for more successful integration of AI into the curriculum.

Theoretical Implications

In line with previous research, the present study has posited the factor of perceived usefulness as a major predictor for adopting AI technologies among educators (Davis & Granić, 2024; Kelly et al., 2023). The research synthesizes TAM and the Big 5 model, which enables tracing a deeper picture of the factors that may facilitate or hinder the acceptance of technologies (Sánchez-Prieto et al., 2019; Stein et al., 2024). Personality characteristics may play a crucial role in influencing teachers' receptiveness to AI and their willingness to adopt it in their classrooms, thus calling for the development of targeted professional learning interventions that take into account the diverse personality profiles.

The research also establishes that institutional policies are crucial in the integration of AI in learning institutions, making it a critical area that requires policy support and effective policy formulation in learning institutions (Chan, 2023; Fullan et al., 2023). In other words, the more

a school advocates for and encourages the utilization of AI, the higher the levels of AI usage among the staff will be. This requires deliberate planning and measures where educational leaders consider not only the technology resources but also the culture of risk-taking.

Practical Implications

There are several practical implications of this study for educators, school administrators, and policymakers involved in the implementation of AI in education. These implications present recommendations to be applied towards improving the utilization of AI tools in educational environments.

The results of this study highlight the need for designing and delivering administrative support and professional development opportunities that consider the personality traits of teachers. Since such characteristics as openness to experience and innovativeness strongly relate to AI use (Sánchez-Prieto et al. 2019; Stein et al. 2024), professional development programs should account for existing diversity in teachers' technological literacy and openness for change. For example, the teachers with lower levels of openness might need the AI technologies to be introduced to them in step-by-step manner through the professional development sessions and through the hands-on training that addresses their concerns (Ding et al., 2024). For those educators who are ready for innovations, advanced workshops focusing on innovative uses of AI in pedagogy could be more appropriate.

In this context, school policies have paramount importance in promoting the use of AI. Schools are recommended not only to establish strong supportive policies that go beyond providing the appropriate resources, including access to AI tools and technical support, but also to foster a culture of innovation (Chan, 2023; Fullan et al., 2023). Policies should also consider the physical and social aspects of deploying AI in schools. This involves creating an environment that encourages experimentation and diminishes the fear of failure among teachers. Effective communication of the benefits of AI can further enhance teacher buy-in and support for these initiatives. To mitigate the bias inherent in AI systems, schools should develop policies on data protection, consent, and data usage.

Limitations of the Study

This study also has the following limitations, which might have an impact on the generalizability of the findings. Initially, the study is based on self-reported data; it should be acknowledged that this type of data is subjected to interpretation errors. Although several techniques were used to minimize these biases, it cannot be claimed that they have not been completely eradicated. Second, the sample of educators participating in the study was limited to teachers from private schools in Azerbaijan, which may hinder the generalization of the findings to the population of teachers in other countries and various educational environments. There are also other contextual factors related to AI that likely affect the extent to which teachers use AI, including the internet connection or the school's technological infrastructure as well as IT assistance. Expanding the range of methodological approaches, involving more

participants, and considering the circumstances in which teachers integrate AI technologies into their practice will contribute to a better understanding of the field.

Conclusion and Recommendations

This research has established that perceived usefulness and supportive institutional policies are crucial in contributing to the adoption of AI technologies in education. The study emphasizes how crucial it is that educators comprehend and acknowledge the real-world advantages of AI, such as increased pedagogical effectiveness and customized learning opportunities for students (Kelly et al., 2023). These insights facilitate the easier incorporation of AI tools into educational settings. Educational institutions are encouraged to foster an environment that not only supports but actively promotes the integration of AI through clear policies and frameworks. This support is essential for educators to feel secure and competent in utilizing AI technologies, thus reducing the resistance associated with adopting new technologies in the classroom (Obae et al., 2024).

Notably, institutional support is one of the significant factors that emerged in the analysis of the findings. To support AI adoption, educational institutions need to enhance policies that create a favorable environment that stipulates AI's usage and provide extensive training for such purposes (Chan, 2023; Fullan et al., 2023). These policies should also guarantee the provision of the underlying technologies, as well as support the culture of innovative use of AI in the class and remove the culture of fear of trying new ideas from educators by embracing the failure attempts as a positive step towards achieving the necessary integration of AI in the learning process. The research findings advocate for educational reforms that will assist the integration of AI literacy into existing curricula, suggesting that such integration should be informed by an evidence-based approach to enhance the content and effectiveness of AI education. It is crucial that these educational strategies encompass both the technological and pedagogical aspects of AI to ensure that teachers are not only users but proficient implementers of AI tools (Le Borgne et al., 2024).

In addition, the results of this study indicated that there is a need for continuing professional development in conjunction with the identified strategies. This would assist educators in appropriately adapting to further advancements in AI technology for use in teaching. Such training should be more nuanced to reflect the differences in readiness and perceptions towards technology among teachers, in order to meet a range of needs starting from a fundamental introduction to AI technology up to the methodological applications of this concept (Ding et al., 2024).

Looking ahead, there are some ideas that are worth exploring in more detail in the future. More in-depth quantitative research may help to describe long-term changes in teachers' technological beliefs as well as examine the various conditions that may have an impact on the use of AI among teachers. This approach can encompass one-on-one interviews or focus group discussions to obtain detailed information in regards to the psychosocial effects of AI in learning environments.

Furthermore, a longitudinal study could explore how the incorporation of AI into teaching and learning would impact teaching practices and learners' performance in the long-run, which would be instrumental in tackling the question of the sustainability of technology integration in learning and development as well as its benefits and drawbacks over time. A further investigation of AI adoption in different education settings, like public schools or institutions from different geographical regions, will also add to the knowledge of the factors that affect the implementation of AI in an educational arena.

References

Al Darayseh, A. (2023). Acceptance of Artificial Intelligence in teaching science: Science teachers' perspective. *Computers and Education: Artificial Intelligence*, *4*. https://doi.org/10.1016/j.caeai.2023.100132

American Psychological Association. (2017). *Ethical principles of psychologists and code of conduct*. American Psychological Association. Retrieved from https://www.apa.org/ethics/code

Arvidsson, I., Leo, U., Larsson, A., Håkansson, C., Persson, R., & Björk, J. (2019). Burnout among school teachers: Quantitative and qualitative results from a follow-up study in Southern Sweden. *BMC Public Health*, *19*(1). https://doi.org/10.1186/s12889-019-6972-1

Bauwens, R., Muylaert, J., Clarysse, E., Audenaert, M., & Decramer, A. (2020). Teachers' acceptance and use of digital learning environments after hours: Implications for work-life balance and the role of Integration Preference. *Computers in Human Behavior*, *112*. https://doi.org/10.1016/j.chb.2020.106479

Chan, C. K. (2023). A comprehensive AI Policy Education Framework for university teaching and learning. *International Journal of Educational Technology in Higher Education*, *20*(1). https://doi.org/10.1186/s41239-023-00408-3

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly, (13)*3, 319–340. https://doi.org/10.2307/249008

Davis, F. D., & Granić, A. (2024). *The Technology Acceptance Model: 30 years of Tam*. Springer Nature. https://doi.org/10.1007/978-3-030-45274-2

De Jong, J.P.J. and Hartog, D.N.D. (2008) Measuring Innovative Work Behavior. *Scales Research Reports*. EIM Business and Policy Research.

Ding, A.-C. E., Shi, L., Yang, H., & Choi, I. (2024). Enhancing teacher AI literacy and integration through different types of cases in teacher professional development. *Computers and Education Open*, *6*. https://doi.org/10.1016/j.caeo.2024.100178

Fullan, M., Azorín, C., Harris, A., & Jones, M. (2023). Artificial Intelligence and school leadership: Challenges, opportunities and implications. *School Leadership and Management*, 1–8. https://doi.org/10.1080/13632434.2023.2246856

García-Martínez, I., Fernández-Batanero, J. M., Fernández-Cerero, J., & León, S. P. (2023). Analysing the impact of Artificial Intelligence and Computational Sciences on student performance: Systematic review and meta-analysis. *Journal of New Approaches in Educational Research*, *12*(1), 171–197. https://doi.org/10.7821/naer.2023.1.1240

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A Review. *Sustainable Operations and Computers*, *3*, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Karakose, T., & Tulubas, T. (2024). School leadership and management in the age of Artificial Intelligence (AI): Recent developments and future prospects. *Educational Process International Journal*, *13*(1). https://doi.org/10.22521/edupij.2024.131.1

Kaya, F., Aydin, F., Schepman, A., Rodway, P., Yetişensoy, O., & Demir Kaya, M. (2022). The roles of personality traits, AI anxiety, and demographic factors in Attitudes Toward Artificial Intelligence. *International Journal of Human–Computer Interaction*, *40*(2), 497–514. https://doi.org/10.1080/10447318.2022.2151730

Kelly, S., Kaye, S.-A., & Oviedo-Trespalacios, O. (2023). What factors contribute to the acceptance of artificial intelligence? A systematic review. *Telematics and Informatics*, *77*. https://doi.org/10.1016/j.tele.2022.101925

Le Borgne, Y.-A., Bellas, F., Cassidy, D., Vuorikari, R., & Kralj, L. (2024). (rep.). *Teachers' competences*. European Digital Education Hub.

Ng, D. T., Leung, J. K., Su, J., Ng, R. C., & Chu, S. K. (2023). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educational Technology Research and Development*, *71*(1), 137–161. https://doi.org/10.1007/s11423-023-10203-6

Obae, C., Niewint-Gori, J., Bellas, F., Pasichnyk, O., Janakievska, G., Gilleran, A., Le Borgne, Y.-A., Vuorikari, R., Sharma, M., & Kralj, L. (2024). (rep.). *Education about AI*. European Digital Education Hub.

Ofosu-Ampong, K. (2024). Beyond the hype: Exploring faculty perceptions and acceptability of AI in teaching practices. *Discover Education*, *3*(1). https://doi.org/10.1007/s44217-024-00128-4

Ofosu-Ampong, K., Acheampong, B., Kevor, M.-O., & Amankwah-Sarfo, F. (2023). Acceptance of Artificial Intelligence (ChatGPT) in education: Trust, innovativeness and psychological need of students. *Information and Knowledge Management*, *13*(4), 37–47. https://doi.org/10.7176/ikm/13-4-03

Owan, V. J., Abang, K. B., Idika, D. O., Etta, E. O., & Bassey, B. A. (2023). Exploring the potential of artificial intelligence tools in educational measurement and assessment. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(8). https://doi.org/10.29333/ejmste/13428

Rahman, M., & Watanobe, Y. (2023). ChatGPT for education and research: Opportunities, threats, and strategies. *Applied Sciences*, *13*(9), 5783. https://doi.org/10.3390/app13095783

Roczniewska, M., Puchalska-Kamińska, M., & Łądka-Barańska, A. (2020). Facing education reform: Change-related self-efficacy is linked to job insecurity via appraisal. *Economic and Industrial Democracy*, *43*(3), 1164–1188. https://doi.org/10.1177/0143831x20975479

Sánchez-Prieto, J. C., Cruz-Benito, J., Therón, R., & García-Peñalvo, F. J. (2019). How to measure teachers' acceptance of AI-driven assessment in eLearning. *Proceedings of the Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality*. https://doi.org/10.1145/3362789.3362918

Seibert, D., Godulla, A., & Wolf, C. (2021). Understanding how personality affects the acceptance of technology: A literature review. Leipzig. Retrieved from https://nbn-resolving.org/urn:nbn:de:0168-ssoar-75164-7

Sindermann, C., Yang, H., Elhai, J. D., Yang, S., Quan, L., Li, M., & Montag, C. (2022). Acceptance and fear of Artificial Intelligence: Associations with personality in a German and a Chinese sample. *Discover Psychology*, *2*(1). https://doi.org/10.1007/s44202-022-00020-y

Stein, J.-P., Messingschlager, T., Gnambs, T., Hutmacher, F., & Appel, M. (2024). Attitudes towards AI: Measurement and associations with personality. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-53335-2

Uygun, D. (2024). Teachers' perspectives on Artificial Intelligence in education. *Advances in Mobile Learning Educational Research*, *4*(1), 931–939. https://doi.org/10.25082/amler.2024.01.005

Corresponding author: Rena Alasgarova
Email: rena.alasgarova@mtk.edu.az

Perception of ChatGPT Usage for Homework Assignments: Students' and Professors' Perspectives

Irena Miljkovic Krecar
VERN' University, Croatia

Maja Kolega
VERN' University, Croatia

Lana Jurcec
University of Zagreb, Croatia

Abstract

In the context of education, the issues of integrating artificial intelligence (AI) into teaching and maintaining academic integrity in students' use of AI are particularly relevant. This paper empirically examined the issue of ChatGPT usage for writing homework from the perspectives of students and professors. Study research methods included both quantitative and qualitative approaches. In Study 1, an anonymous questionnaire was administered to 350 Croatian students, users of ChatGPT, to investigate their perceptions, attitudes, habits, and intentions regarding ChatGPT usage for homework assignments. In Study 2, twelve faculty members were tested on their accuracy of distinguishing between original students' papers and ChatGPT-generated papers. For this purpose, 25 different versions of papers for 8 different courses were prepared. The results of the students' survey showed that most students still do not use ChatGPT regularly and have neutral attitudes about its usefulness, ease of use, risks, and intentions for future use. In addition, they were moderately concerned about ethical issues around its usage. Differences across gender and field of study were found. Professors, on the other hand, reported having average self-efficacy in appraising authorship, which is in line with their low average accuracy of 53%. Accuracy in distinguishing was lowest when ChatGPT was instructed to write a paper as a student. These results strongly suggest the necessity for clear guidelines, plagiarism detection tools, and educational initiatives to promote ethical use of AI technology.

Keywords: academic integrity, attitudes, ChatGPT ethical considerations, higher education, students' and professors' perspectives

In the dynamic development of higher education, implementing Artificial Intelligence (AI) in the classroom introduces many different opportunities and even more complex challenges. One of the main challenges is how to balance the indisputable advantages of technology with maintaining academic integrity. Academic integrity is the foundation of higher education, encompassing principles such as responsibility, honesty, trust, and fairness. Kiralj (2020) emphasizes that students are the driving force behind the future strength of society. Student honesty is essential, not only for academic success but also for their future work ethics, which is a prerequisite for economic and social development. The question of authorship and originality becomes increasingly complex in an academic environment where AI could significantly contribute to content creation.

Educators play a crucial role in fostering a culture of academic integrity. By adapting pedagogical approaches that emphasize critical thinking and originality, educators can empower students to use technology without compromising academic integrity. However, it also means they should adapt to new circumstances and accept new challenges, continuously improving their digital competencies.

This paper aims to address two important questions:

1. What are the students' habits and attitudes towards the use of ChatGPT in writing homework assignments, with an emphasis on the ethical component of their use?
2. Can educators distinguish between the papers generated by ChatGPT and the ones written by their students?

In the following section, an overview of previous research on the use of AI in education is provided. Subsequently, the methodology of the empirical study conducted with a group of students and professors is described. The results are then presented alongside the discussion, followed by the conclusion with practical guidelines and recommendations.

Literature Review

Many scholars have highlighted multiple benefits of using ChatGPT for students and educators for educational purposes: it could serve as a starting point for personalized learning and provide personalized feedback; support individual and group research, provide ideas and guidance on designing and adapting educational content to make it more appealing and accessible to students; improve writing skills, especially in English; offer various possibilities for disabled students; and improve time efficiency (Dwivedi et al., 2023; Kasneci et al., 2023; Memarian & Doleck, 2023; Rahman et al., 2023; Rasul et al., 2023; Sok & Heng, 2023). This innovative way of learning could improve student's motivation and engagement in acquiring new knowledge and skills, providing educators time to focus on more demanding tasks such as developing students' critical thinking, complex problem-solving, responsible decision-making, communication skills, and so on, and give students emotional support in their progress.

Rasul and colleagues (2023) summarized five main challenges of using GPT in an academic context: academic integrity, reliability, inability to evaluate and reinforce graduate skill sets, limitations in assessing learning outcomes, and potential biases and falsified information in information processing. Further, using GPT could lead to an unfair disadvantage for students who do not have access to it (Dwivedi et al., 2023).

Previous research shows that both professors and students have a positive attitude towards using ChatGPT for educational purposes, albeit with concerns, predominantly centered on the accuracy of the generated data (Chan & Hu, 2023; Kiryakova & Angelova, 2024; Lozano & Blanco Fontao, 2023). Simultaneously, professors have a more negative attitude toward using ChatGPT, considering cheating and plagiarism as a major challenge (Iqbal et al., 2022; Nguyen, 2023; Waltzer et al., 2023). The assessment of students' work in the form of essays, projects, research papers, or similar tasks, often conducted remotely, is a pivotal component of higher education. These assignments serve to evaluate a broad spectrum of learning outcomes, including the ability to locate, summarize, and paraphrase relevant literature, critical analysis skills, creativity, innovation, and attitudes. In achieving educational outcomes maintaining academic integrity despite the easily accessible online tools that can complete most of the work becomes a great challenge. Although research indicates that online cheating is more prevalent than traditional offline cheating, studies on online academic dishonesty are still in the early stage (Chiang et al., 2022). Despite the prevailing belief among most students that cheating is ethically wrong, they frequently rationalize their engagement in academic cheating (Majstorović, 2016; Waltzer & Dahl, 2023). Prior research suggests that various motivational factors significantly influence students' decision to cheat (Miles et al., 2022; Sozon et al., 2024; Waltzer & Dahl, 2023). For example, lack of understanding of what academic misconduct is, increased pressure on students, fear of failure, time pressure, lack of motivation, lack of institutional policy, perceived risk and penalties, and peer influence. According to Zhao and colleagues (2022) perceived peer cheating is significantly stronger than other factors and plays a crucial role in students' academic cheating behavior. Considering all these factors that influence attitudes toward academic dishonesty, it is essential to also consider perspectives on technology use to gain a more comprehensive understanding of attitudes toward the use of AI in academic settings. Measuring attitudes toward ChatGPT usage for homework assignments serves as the initial step towards understanding present behaviors and forecasting future conduct.

In this paper the Technology Acceptance Model (TAM; Davis, 1989) was used as the fundamental theoretical framework. TAM emerged as a modification of the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1980) and the Theory of Planned Behavior (TPB; Ajzen, 1985), both cited in Ajzen 1991 and is frequently employed to examine how users interact with various technologies. According to TAM, two factors determine whether a new technology will be embraced by its potential users: (1) perceived usefulness and (2) perceived ease of use. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" while perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). If a new technology is considered easy to use, there is an increased

likelihood that it will also be perceived as useful, thereby enhancing its acceptance. Over time, TAM has evolved to become the key model in understanding the potential acceptance or rejection of technology, which is of special importance for educational challenges in a digital environment. Although the application of TAM has confirmed its robustness, the model's simplicity and the limited understanding of the antecedents of technology acceptance led to the development of extended versions such as TAM 2 (Venkatesh & Davis, 2000) and TAM 3 (Venkatesh & Bala, 2008). Despite these models, numerous scholars continue to use the original TAM, extending it with variables and theories relevant to their specific study contexts (Sukackė, 2019).

Numerous studies have confirmed TAM in the field of education (Abdullah & Ward, 2016; Granić & Maragunić, 2019; Sherer et al., 2019) showing the significance of perceived usefulness and perceived ease of use in understanding students' attitudes towards using ChatGPT for learning (Obenza et al. 2024; Rahman et al., 2023; Shaengchart, 2023). Also, several studies have shown that AI can produce high-quality materials in different disciplines (Herbold et al., 2023; Susnjak, 2022; Yeadon et al., 2023) and the educators can hardly distinguish students' work from the work written by ChatGPT (Busch & Hausvik, 2023; Fleckenstein et al., 2024; Liu et al., 2023; Waltzer et al., 2023). Bašić and colleagues (2023) highlighted that ChatGPT-assisted writing quality is highly connected with previous knowledge and skills, and inexperienced students could show poorer essay writing performance with its usage. To make use of all the advantages of AI, students need a solid base of knowledge to ask proper and relevant questions.

However, there is still a lack of empirical examination of attitudes toward using ChatGPT as a shortcut for writing homework assignments. Most investigations have been conducted within the domain of English as a Second Language (ESL) instructional essays, with comparatively fewer studies in other disciplinary contexts. This opens numerous possibilities for further research into tailoring home essay instructions across diverse subjects, particularly in the social sciences and humanities, where essay writing constitutes a significant component of the pedagogical process. Additionally, it is crucial to explore the materials produced by ChatGPT in languages other than English, to understand its suitability and potential limitations in multilingual educational settings. This topic is especially important to educational institutions considering the importance of academic integrity preservation. Furthermore, while previous literature strongly suggests that AI (namely ChatGPT) can produce convincing "student works", there is a lack of objective empirical evidence on how proficient professors are in distinguishing between student work from AI-generated content in various courses.

Methodology

Goals

This research has two main goals, first, to empirically examine students' attitudinal components of cognition, emotions, and behaviors related to the use of ChatGPT in homework

assignments. Second, to determine professors' level of accuracy in distinguishing students' own writing from AI generated homework assignments.

The following research questions were formulated for this purpose:

1. What attitudes, habits, and intentions do students have when utilizing ChatGPT for writing homework assignments, with a particular emphasis on the ethical dimension of their usage?
2. Are there significant differences in ChatGPT usage perceptions, attitudes, and habits between students of different gender and field of study?
3. Can professors accurately discriminate between homework assignments written by students and those generated by ChatGPT?

An online survey of 350 students from various Croatian universities (Study 1) and a workshop with 12 professors from VERN' University[1] (Study 2) were conducted in December 2023 to answer the research questions. This included both quantitative and mixed (quantitative-qualitative) approaches. The studies adhered to key ethical considerations, including voluntary participation, informed consent, and the maintenance of anonymity and confidentiality. Participants were fully informed about the research purpose, procedures, and their right to withdraw at any time without negative consequences. Ethical approval was obtained from the institution's ethics committee.

To ensure clarity, we first present the method, findings, and discussion of the results of the students' survey, followed by the same information for the sample of professors. Finally, the paper addresses limitations of the research and provides a common conclusion.

Study 1: Students' Survey

Method

The questionnaire for students about their perceptions, attitudes, habits, and ethical issues related to ChatGPT usage was constructed based on the TAM model (perceived usefulness, perceived ease of use and intentions) and research questions. Some items were created resulting from student-led debate (organized for this purpose with 40 students) on the use of ChatGPT in homework assignments[2]. Clarity of the items was pilot tested on another group of 15 students. Besides sociodemographic questions, the final version of the questionnaire contained items about ChatGPT usage in completing homework assignments: (1) habits, (2) level of

[1] Two of the three authors are employed at VERN', which was chosen for the research due to practical reasons. Most of the initial students' sample are from VERN' (N=227). When the desired sample size was not achieved, the call for participants was extended to other Croatian students through the private and professional networks of the authors.

[2] The debate was conducted as part of regular psychology classes with two groups of students from the VERN' University (Cyber communication and network sciences (N=25) and Business IT (N=15)). The professor who conducted the debate is also an author of this paper.

acceptability, (3) attitudes, (4) ethical issues, and (5) perception of professors' knowledge of ChatGPT.

Habits were measured by *frequency* of ChatGPT usage for completing homework assignments on the scale of five (1 - *few times only*, 2 - *few times a month*, 3 - *once or twice a week*, 4 - *several times a week*, 5 - *every day*), and a multiple choice-multiple select question about the purpose of using ChatGPT, offering 16 *purposes*.

Level of acceptability to use ChatGPT when writing homework was measured by one item on a 10-point scale, ranging from 1 (*to give me some initial information or serve as inspiration*) through 5 and 6 (*to take over half of the written content, and shape and complete the rest myself*) to 10 (*to completely write a paper or task for me, which I will then hand over to the teacher without changes*).

Attitude Towards ChatGPT Usage *in Completing Homework Assignments scale* contained 16 items rated on a 5-point Likert-type scale, ranging from 1 (*absolutely disagree*) to 5 (*absolutely agree*). Exploratory factor analysis (EFA) extracted a four-factor solution and accounted for 63.5% of the total variance. Each factor consisted of four statements about ChatGPT usage for writing homework assignments. *Intention (F1)* measured planned behavior of utilizing ChatGPT for tasks deemed too challenging, tedious, time-consuming, and so on, for the students; *Risk of Use (F2)* referred to students' diminishing learning adaptability, critical thinking abilities, and academic skills; *Easy and Reliable Use (F3)* measured trust in the accuracy of the given information and the ease of ChatGPT use*; Usefulness (F4)* was about fostering the development of students' computer skills, creativity, interest, and enjoyment (See Appendix A). The obtained factors supported both TAM (Shaengchart, 2023; perceived usefulness, ease of use and intentions to use ChatGPT) and TAME-ChatGPT (Abdaljaleel et al., 2024; perceived usefulness, behavioral/cognitive factors, perceived risk of use, perceived ease of use) models and scales. Subscales showed adequate reliability (α) as follows: .85, .80, .76, .80.

Ethical Issues of ChatGPT Usage in Completing Homework Assignments Scale consists of four-items describing the potential implications ChatGPT usage may have on academic integrity. Items were rated on a 5-point Likert-type scale, ranging from 1 (*absolutely disagree*) to 5 (*absolutely agree*). EFA extracted a one-factor solution (Appendix B) and accounted for 63.5% of the total variance. Ethical Issues as separate scale is in line with Farhi and colleagues. (2023) who highlighted concerns regarding ethics of the potential over-reliance on ChatGPT for educational tasks. The scale showed adequate reliability (α=.77).

Perception of Professors' Knowledge of ChatGPT were measured with four items focusing on how students perceive professors' abilities to detect ChatGPT papers. Items were rated on a 5-point Likert-type scale, ranging from 1 (*absolutely disagree*) to 5 (*absolutely agree*).

Snowball sampling was used to recruit Croatian students. Along with a link to the questionnaire, participants were informed about research's core components and that their

involvement was voluntary and anonymous, with no credits awarded for participation. The final sample, consisting of 350 students, was selected based on the criteria of having personal experience in using ChatGPT for study purposes. 61.1% were females and the total sample ranged in age from 18 to 46 with a mean age of 23 years (M=22.75, SD=5.52). Students were at the undergraduate (68.3%) and graduate (31.7%) levels of education from different fields of study: 58% of students were majoring in social sciences, 34.3% in science and technology, 6.3% in humanities, 1.1% in medical sciences, and 0.3% in arts.

Results

Data were analyzed using the Statistical Package for Social Sciences, version 26.0 (SPSS Inc., IL). For most variables, the values of skewness and kurtosis were between +1 and -1, except for the variable *purposes*. Nonparametric statistics were used for skewed and ordinal variables and parametric for interval variables with normal distribution. Therefore, with Mann-Whitney (M-W) U test and two-way analysis of variance (ANOVA) we tested the effect of gender and field of study differences (Cohen *d* and partial eta squared ηp^2) on items and scales of ChatGPT usage. The level of statistical significance was p=.05.

Students Habits and Acceptability to Use ChatGPT in Completing Homework Assignments

Our analysis (Table 1) showed that most students have not developed the habit of using ChatGPT in completing their homework assignments. Half of them used it only a few times by now (50.6%) and the rest of them use it few times a month (24.3%), or on the weekly basis (22.5%), and only few admitted using it daily (2.6%). It was more often used by male than female students (d=0.63), and by science and technology students than social sciences students (d=0.58).

On a 10-point acceptability scale almost one third (29.4%) of students considered ChatGPT usage as acceptable tool for getting some initial information or serving as inspiration (level 1). Most students (74.8%) found it unacceptable to take over half of the written content, and shape and complete the rest themselves (level 5 and 6) while the rest found it acceptable. The usage of ChatGPT to completely write a paper or task (level 10) was considered acceptable by one percent of the students. The median indicated that the average acceptability level was 3 (Table 1). Male students rated its usage as more acceptable than female students did (d=0.24).

Table 1

Gender and Field of Study Differences in Experiences of ChatGPT Usage in Completing Homework Assignments

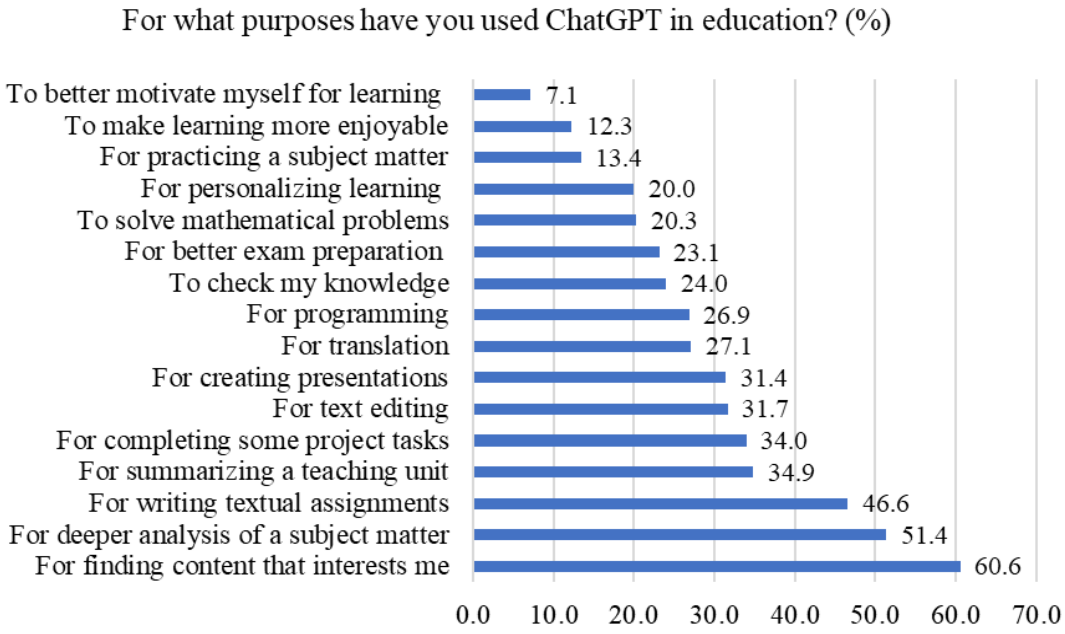
Variables	Groups	Median	Mean Rank	M-W U test	Z	p
Frequency	Male	2	213.75	9350	-6.10	.000
	Female	1	151.19			
	Soc. Sci.	1	142.03	8127.0	-5.39	.000
	Sci. Tech.	2	195.78			
Purpose	Male	5	210.49	9793.5	-5.20	.000
	Female	4	153.26			
	Soc. Sci.	4	146.24	8981.0	-3.98	.000
	Sci. Tech.	5	188.66			
Acceptability	Male	3	190.74	12479.5	-2.30	.022
	Female	3	165.82			
	Soc. Sci.	3	163.12	11952.5	-0.29	.774
	Sci. Tech.	3	160.10			

Note. Soc.Sci.=Social Science, Sci.Tech.=Science and Technology

On average, students chose four purposes (*Median*=4) of using ChatGPT in completing their homework assignments, and as Figure 1 presents, mostly for finding content that interests them, deeper analysis of a subject matter and for writing textual assignments (essays, seminars, reviews, etc.). Male students (d=0.58) and those studying technical sciences (d=0.39) had more reasons for its usage (Table 1), which is in line with the previously mentioned higher frequency of use within these subsamples.

Figure 1

Reasons for Utilizing ChatGPT in Completing Homework Assignments (%)



Attitudes and Ethical Issues Regarding ChatGPT Usage in Completing Homework Assignments

As evident in Table 2, average ratings of 3 (neutral opinion) were obtained on all scales, with standard deviations suggesting not much variation. Two-way ANOVAs were conducted on the scales to determine potential differences between male (*N*=130) and female students (*N*=193), as well as students majoring in social sciences (*N*=203) and science and engineering (*N*=120). The subsamples for testing interaction effects consisted of males majoring in social sciences (*N*=50) and in science and engineering (*N*=80), and females majoring in social sciences (*N*=153) and in science and engineering (*N*=40).

Results of ANOVA showed that male students perceived more usefulness (ηp^2=.022), and less risks (ηp^2=.013) in using ChatGPT than female students. They are also intended to use it more than female students (ηp^2=.018). Field of study also showed significant effect on intention and reliability. Social science students had more confidence in ChatGPT (ηp^2=.028) and higher intention to use it for future assignments (ηp^2=.027) in comparison to science and technology students.

Table 2

Gender and Field of Study Differences in Attitudes Towards ChatGPT Usage in Completing Homework Assignments

	Descriptive statistics M (SD					*ANOVA*		
Scales	M	F	Soc.Sci.	Sci.Tech.	Total	F_{gender}	F_{field}	$F_{Interaction}$
Risks	3.13 (1.06)	3.42 (0.97)	3.34 (0.98)	3.24 (1.06)	3.31 (1.01)	4.14*	0.03	2.26
Usefulness	3.42 (0.98)	3.13 (0.91)	3.25 (0.96)	3.23 (0.93)	3.24 (0.95)	7.34**	2.05	2.99
Easy & Reliable	3.13 (0.81)	3.18 (0.80)	3.26 (0.78)	2.99 (0.76)	3.16 (0.79)	.46	9.31**	0.01
Use Intention	2.88 (1.13)	2.71 (0.99)	2.87 (1.04)	2.62 (1.05)	2.78 (1.05)	5.95*	8.73**	0.35
Ethical Issues	2.70 (1.03)	2.95 (0.92)	2.87 (0.98)	2.82 (0.97)	2.85 (0.97)	3.23	0.42	8.92**

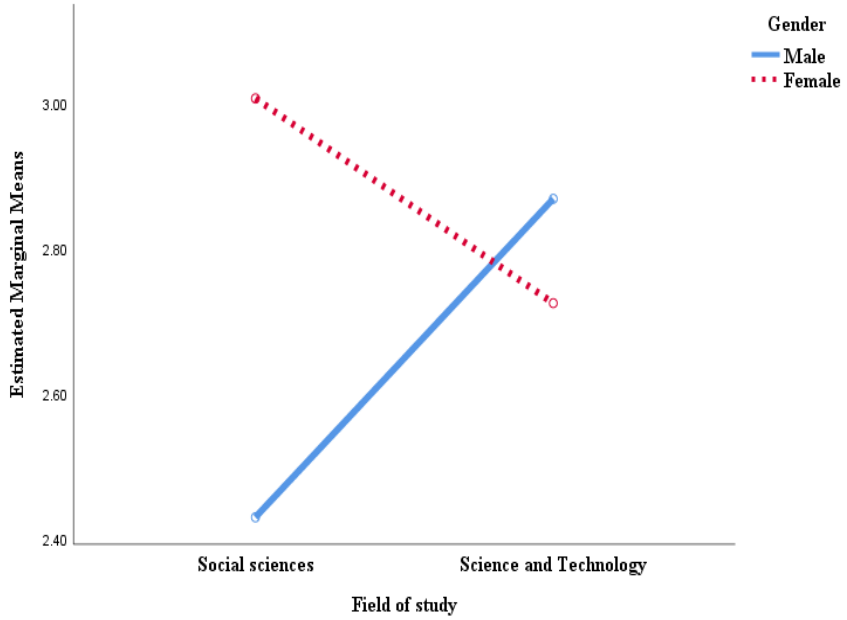
Note. * p<.05, **p<.01; Soc.Sci.=Social Science, Sci.Tech.=Science and Technology.

The results revealed statistically significant interaction effect of gender and field of study on perceived ethical issues on ChatGPT usage when doing homework assignments (ηp^2=.027). In

social sciences female students were most concerned about potential implications on academic integrity while male students had least ethical doubt (Figure 2).

Figure 2

Interaction Effect of Gender and Field of Study on Perceived Ethical Issues on ChatGPT Usage When Doing Homework Assignments



Perception of Professors' Knowledge of ChatGPT

Table 3 shows the students mostly had a neutral opinion on professors' knowledge of ChatGPT. Nearly half of the students (42.7% and 46.5% answered *absolutely or mostly disagree* on the five-point scale for first two items) were completely or mostly convinced in professors' efficacy of appraising authenticity of student papers, even though nearly equal percentage of the students expressed concern about objectivity of the assessment practices (39.4% answered 4-*mostly agree* or 5-*absolutely agree*). Twenty-two percent of students agreed that it is up to the students to manage their assignments, while it is the professors' responsibility to identify any misuse.

Table 3
Students' perceptions of professors' knowledge of ChatGPT (%)

Items/Scale	1	2	3	4	5	M	SD
Most professors do not verify the authenticity of student papers.	14.0	28.7	30.9	15.8	10.6	2.80	1.18
Teachers cannot detect whether homework assignments were written by ChatGPT or the student.	22.8	23.7	30.6	15.9	6.9	2.60	1.20
It is up to us students to 'get by' with the help of ChatGPT, and it is up to the professors to try to catch us in that.	31.7	20.6	25.7	12.0	10.0	2.48	1.31
Due to ChatGPT, homework assignments cannot be objectively evaluated.	10.4	15.6	34.6	25.6	13.8	3.17	1.16

Discussion

As seen in our sample of Croatian students, male students use ChatGPT more than female, consistent with previous studies (Draxler et al., 2023; Siregar et al., 2023). Similarly, in Germany male students and students of engineering sciences, mathematics and natural sciences used AI-based tools most frequently (von Garrel & Mayer, 2023). According to Bouzar et al. (2024) males reported longer usage times, indicating a potentially deeper engagement with the tool, while females demonstrated higher usage frequency, suggesting more frequent interactions but possibly for shorter durations.

The unethical usage of ChatGPT (to completely write a paper or task) was considered acceptable by only one percent of the students, with male students rating it more acceptable than female. Such findings come as no surprise, as many previous studies suggest that male participants are more prone to unethical academic behavior than female participants (Zhang et al. 2017).

Furthermore, results of ANOVA showed that male students perceived more usefulness and less risks in using ChatGPT than female students. They also intend to use it more than female students. Yilmaz and colleagues' (2023) findings that male students found ChatGPT easier to use then female students, similarly, sheds light on the gender-specific responses to the user-friendliness of ChatGPT. The authors observed that understanding these gender-specific responses is crucial for designing AI systems that are inclusive and accessible to all users, regardless of gender. In our sample we can assume that both genders have equal access to ChatGPT; therefore, it is crucial to explore why female students exhibit less interest in technological innovations and have not fully explored the benefits of using this tool.

Field of study also has a significant effect on intention and reliability. Social science students had more confidence in ChatGPT and higher intention to use it for future assignments in comparison to science and technology students. This is somewhat surprising as we have previously seen that they use it less. We can assume that they are just discovering its possibilities, as opposed to science and technology students who might have a better knowledge and steadier dynamic of ChatGPT usage.

Additionally, two-way ANOVA indicated a statistically significant interaction between gender and field of study on perceived ethical issues related to ChatGPT usage. Female students in social sciences were the most concerned about the potential impact on academic integrity, whereas male students in social sciences had the least ethical concern. These results are in line with recent research showing that chatbots are perceived by students as a valuable tool for extensive research and analysis, often required in disciplines such as social sciences (Chan, 2023; Jowarder, 2023), however, women have more negative attitudes towards academic dishonesty (Witmer & Johansson, 2015).

Finally, students mostly held a neutral view on professors' knowledge of ChatGPT. Nearly half of them were completely or mostly confident in professors' ability to appraise the authenticity of student papers, although a nearly equal percentage expressed concern about the objectivity of future assessment practices. Additionally, 22% of students agreed that it is the students' responsibility to find their own way in doing assignments and the professors' role to catch any misconduct. Given this attitude, if students are made aware that the consequences for committing academic dishonesty were little to non-existent, then students are likely to commit such acts (DiPietro, 2010). According to San Jose (2022), students interpreted teachers' leniency during the pandemic as implicit consent to cheat on exams and even plagiarize their submitted outputs. This lack of action or tolerance from teachers is likely to lead to an increase in academic dishonesty.

Study 2: Professors' Survey

Method

Main goal of the professor's survey was to estimate their (subjective) self-efficacy and actual (objective) efficacy in determining the authorship of student homework. Also, the aim was to raise awareness about possibilities and ease of utilization of AI for unethical purposes among students, encourage mutual discussion and to initiate certain steps at the institutional level to effectively address this challenge.

For practical reasons, focus of recruitment was all full-time faculty members of VERN' University. They were sent an invitation to participate in "the workshop related to the use of artificial intelligence". Although initially more of them applied, the final workshop had 12 professors from various disciplines. Among them 2 were males and 10 females, and majority of them have at least 15 years of teaching experience at the same institution (besides one younger male professor with "only" 8 years of teaching experience).

Weeks before the study, professors were requested to provide homework instructions from their courses, contributing to the final grade. They were also asked to submit several examples of student homework of varying quality, focusing on assignments submitted before November 2022 (when ChatGPT became widely used). Based on their contributions, materials for the survey were created.

The following eight courses were selected for the study: Academic Writing, Basics of Marketing, Organizational Psychology, Management, Research Methodology, ICT in Hospitality, Transmedia Storytelling, and Basics of Entrepreneurship. For each course, 2 to 5 variants of assignments were created (25 in total), including both original student work and assignments written by ChatGPT. The proportion of ChatGPT-generated papers ranged from 50% to 66% per course. Most ChatGPT papers were created using the free 3.5 version, with the instructions from the professors directly copied as a prompt. More complex papers, including graphical displays of fictitious results or summaries of scientific papers, were crafted with a prepaid version 4. In some cases, ChatGPT was instructed to write poorly to simulate a struggling student's work.

The workshop began with an overview of the survey results conducted on students (described earlier), with the aim of raising awareness of the presence of AI use and discussion about its threats to academic integrity. The main part of it was professors' evaluation of the authorship of different course papers. Each professor received a folder containing mixed (student and AI-generated) papers written for a particular course. All texts were formatted uniformly (font, size, alignment), and professors were instructed not to judge based on these elements.

For each paper professors answered three questions:

1) Who wrote the text (AI or student)?
2) How confident are they (on a scale from 1 to 5) in their appraisal?
3) How did they determine (open-ended question) the papers' authorship?

After reviewing and grading all the papers in the folder, they took another folder, with a different course, and passed their folder to the next evaluator. Professors were instructed to keep their grades sealed in a closed folder to avoid influencing the subsequent assessors. They evaluated the texts at their own pace and were not required to review all 8 courses but were encouraged to select courses related to their teaching area. After about 45 minutes it was deemed that the professors were saturated, and the exercise concluded, with each course being evaluated by at least 5 professors, and up to 9 in some cases.

Results

Before being provided with materials to assess assignments authorship, professors self-appraised (using the Curi.live platform) their efficacy in this task, on one question with answers ranging from 1 (very low) to 5 (very high). The average score obtained from 12 teachers was 3, indicating a medium level of self-efficacy.

A review of the completed evaluation sheets revealed that the accuracy of the assessed paper's originality varied significantly, ranging from 17% to 100% across the 8 courses and 25 papers. The average overall accuracy rate was 53.75% which is akin to a *roll of the dice*. The average confidence in one's assessment also fluctuates, ranging from 3 to 4.33 per individual task; however, as evident, this confidence is not accompanied by corresponding accuracy. Table 4 presents the main findings.

Table 4.
Results of Professors' Evaluation of Authorship

Course (task description)	Tasks (author)	Accurately / Total assessed	Average certainty
Academic Writing (5 paragraph essays of different types in English)	AW1 (student)	4/6	3,17
	AW2 (student)	3/6	3,33
	AW3 (AI)	6/6	3,67
	AW4 (AI as poor student)	2/6	4,17
	AW5 (AI)	6/6	3,67
	Average accuracy / certainty	**70%**	**3,6**
Basics of Marketing (1 page, survey questions for different survey topics)	BM 1 (student)	3/5	4,2
	BM 2 (AI)	2/5	3,75
	BM 3 (AI as poor student)	1/5	3,5
	Average accuracy / certainty	**40%**	**3,82**
Organizational psychology (2 pages; parts of research seminar with results section, e.g., graphs on different survey questions)	OP 1 (student)	6/6	3,33
	OP 2 (AI)	3/6	3,4
	OP 3 (AI, asked to write about known Croatian company)	2/5	3,33
	Average accuracy / certainty	**63%**	**3,35**
Management (1 page; movies reviews written to show a clear association to management)	MAN 1 (student)	4/6	4
	MAN 2 (AI)	2/6	3
	MAN 3 (student)	1/6	3,5
	MAN 4 (AI)	1/6	3,33
	Average accuracy / certainty	**33%**	**3,82**
Methodology (Research outline - problems, goals, hypothesis, method, sources- in PPT on 10 slides)	MET 1 (student)	4/6	3,86
	MET 2 (AI, as poor student)	1/6	4
	MET 3 (AI)	6/6	4,29
	Average accuracy / certainty	**61%**	**4,05**

ICT in hospitality (2 pages of a larger seminar; ex of ICT in hospitality found in scientific papers)	ICT 1 (student)	4/8	3,63
	ICT 2 (AI)	4/8	3
	Average accuracy / certainty	**50%**	**3,32**
Transmedia storytelling (1 page; 2 narrative extensions of the same Croatian movie)	TMS 1 (AI)	5/6	4
	TMS 2 (AI)	2/5	4
	TMS 3 (student)	4/6	4,33
	Average accuracy / certainty	**63%**	**4,11**
Basics of entrepreneurship (1 page; part of a larger paper - an interview with an entrepreneur)	BE 1 (student)	6/9	4,2
	BE 2 (AI, asked to write emotionally)	3/9	3,78
	Average accuracy / certainty	**50%**	**3,99**

For the Academic Writing course, the average accuracy is the highest among all courses at 70%. Moreover, one person appraised the authorship of all four essays correctly. On the other hand, if the AI is instructed to write a poorly crafted paper, professors most frequently misjudge the originality, confidently assuming it to be a student's work. This finding is significant, as students can easily direct AI to produce a paper resembling a student's work, specifying the desired educational level and quality.

In the Basics of Marketing, the accuracy of assessment was 40%, worse than guessing by chance. It might be because, when instructed to mimic a poor student's work, ChatGPT produced highly convincing texts. However, one person (not teaching that course) appraised all three papers correctly. There was a clear correlation between the accuracy of assessment and the confidence in these judgments. The highest average certainty corresponded with the most accurately assessed work, and vice versa.

For Organizational Psychology, the accuracy was high, but certainty in judgments was low. All teachers accurately identified the original student work, likely due to numerous typos. One person (professor of the same course) appraised all three papers correctly. The poorest estimation was for work where AI was instructed to fabricate research on employees of a specific Croatian company, leading professors to believe it was genuine student work. The low certainty in judgments might also stem from ChatGPT 4 creating graphs based on fictional data, a feature unfamiliar to many professors (since it is not available in the free 3.5 version).
In the Management course, the lowest accuracy in total was observed (33%) and no one correctly appraised all four papers. ChatGPT convincingly wrote film reviews, drawing clear parallels with the requested topic and choosing films akin to typical student selections, leading teachers to believe these were authentic student works.

In Methodology, assessment accuracy was among the highest (61%), but no one appraised all the papers correctly. Also, the poorest accuracy was, once again, visible, when ChatGPT was instructed to write a paper as a bad student.

For the ICT in Hospitality course, the average accuracy was 50%, equivalent to guessing, and three professors (not lecturers of the same course) were correct for both papers. Interestingly, professors used nearly identical arguments to classify a work as either student or AI-created. Transmedia Storytelling was evaluated with the highest certainty, and its accuracy was among the better ones (63%), however only one professor (not of the same course) appraised all the three papers correctly. A few of the professors noticed that all the nouns in the text were capitalized, leading them to correctly conclude that the text was AI-generated.

Finally, for the Basics of Entrepreneurship, appraised by most professors (N=9), the average accuracy was 50%, not any better than guessing. Three professors appraised both papers accurately (two of them not lecturing the same course, the third one being anonymous). The AI's capability to write emotional and personal texts misled professors into believing these were student papers, which reflected in a high average certainty of 3.99 in these appraisals.

In Table 5, accurate and inaccurate arguments used by professors to assess the authorship of papers are collectively presented. Arguments employed in the evaluation of genuine student work and ChatGPT-generated work are shown separately. It is evident that professors' assessment criteria are inconsistent, with identical arguments sometimes used to declare something as original student work or to reject its originality.

Table 5

Correct and Incorrect Professors' Arguments for Assessing the Papers' Authorship

Arguments / Author	Correct Arguments	Incorrect Arguments
Student	*Content:* personal details; realistic; childish; shortcomings in the description of results; expression; illogical; imprecise; typical student mistakes; unrelated; it refers to examples; specific details; it sounds authentic; expected work for the student; own opinion. *Form:* spelling; spelling errors; grammar; minor text errors; first-person writing; writing style; simple language; typos; mistakes; I form; short sentences; no numbered tables; formatting tables;	*Content:* no emotions; too professional; no feelings. *Form:* language; sentence structure; no structure, spelling; no source; a lot of foreign terms; style; non-standard Croatian language; advanced language; too good wording for a student; good English.
ChatGPT	*Content:* Arguments; no sources; stereotypically; too professional; it is not the level of students; too good and advanced; complex expressions; great photos; too general; too poetically retold; impeccable. *Form:* brief; writing style; flawless; very neat; technical elements; style and language; eloquently; school template; 1st letter capitalized; uppercase and lowercase letter; colon then enumeration; pictures; ChatGPT style; ornate literary style	*Content:* seems naive; a personal perspective; gut feeling; as expected for a student; too realistic for GPT; like a song; modest; too casual; passionate with own opinion; short and personal; emotional expressions *Form:* style as a student; writing style; strange constructions; sentence structure; spelling; language, style;

Discussion

Before the emergence of ChatGPT and other similar AI tools, various graphic elements – such as different fonts within the same text or differently colored backgrounds of text paragraphs – were used by professors for quick detection of texts that were copy-pasted directly from the internet. However, that "old" plagiarism detection argument in AI simply "doesn't hold water." As seen, our professors have a medium level of self-efficacy (M=3) in assessing the authorship of student assignments versus AI-generated papers. As the sample consisted of 12 highly motivated professors who voluntarily joined the research it is reasonable to presume that these professors may have been more critically oriented and had a lower level of confidence in their judgments compared to other professors who did not respond to the invitation to the workshop, considering that they did not need it. On the other hand, their self-criticism is justified since the objective assessment accuracy is low (53.75%). In a similar research Busch and Hausvik (2023) found that the authors were correctly identified in 60% percent of both the ChatGPT-generated and student-written exam answers. However, as they tested the accuracy in rating exam questions, their results are not fully comparable with ours, as we tested various homework assignments, that usually produce higher quality and quantity variance among students. We therefore assume that in more complex tasks the authorship will be less detectable, and with AI development this problem will only get bigger.

Busch and Hausvik (2023) also suggested that teaching experience correlates with higher accuracy rates. In our sample (although small) we only had experienced professors, so we can speculate whether the accuracy rate would be lower on a more heterogeneous sample or whether it is impossible to go below the random guessing rate. Similarly, Liu et al. (2023) suggest that training (previous exposure) can enhance participants' ability to distinguish between student essays and machine-generated text. Likewise, our results indicate (Table 5) that some AI work is more easily noticeable to (some) professors, e.g., the one that follows the typical format of ChatGPT output, with headings, subheadings, and bullets. This kind of observation can only be drawn from personal experience with ChatGPT, which suggests that professors need to familiarize themselves with the AI tools that their students use. Some professors do not have any experience with ChatGPT and are still surprised with its capabilities and are therefore easier to deceive. Anyone who experiments with it a little can ascertain its capability to produce emotional, creative, personal, and witty content, not to mention the capabilities of premium ChatGPT 4.0 version. Over time, professors will hopefully learn the typical style of texts generated by ChatGPT (or similar popular tools) and will be able to detect at least those who have not made the effort to even format the text independently, let alone write it.

Fleckenstein and colleagues (2024) found that professors were overconfident in their judgments, particularly when they thought a text was written by a student and when the text was of low quality. Likewise, in this research, professors overall tend to label papers that are "too good" as plagiarism, while those showing errors, writing clumsiness, or emotional connotations are deemed original student work. As shown in Table 4, when ChatGPT is instructed to write papers from the perspective of a student, a poor student, or emotionally,

professors exhibit the lowest detection accuracy. In other words, it only takes minimal modification to ChatGPT prompt to make its output almost undetectable. Therefore, it is essential for professors to remain vigilant and continuously update detection methods.

Limitations

This research has a few limitations that need to be considered. Firstly, the sample size of professors was relatively small and consisted mainly of experienced middle-aged individuals. Although the invitation to participate in the research was sent to all professors from the chosen university (33), only 12 responded. This suggests those who participated were particularly motivated and interested in AI in higher education. Additionally, while the student sample was moderately large, it may not fully represent the wider student population as students of social sciences (58%) and females (61.1%) dominated the sample. To address these limitations, future research should aim for larger and more diverse samples.

Secondly, while e-survey questionnaires are convenient, cost-effective, and eco-friendly, they can introduce biases such as self-selection. Students who are more interested or motivated may be more inclined to participate, skewing the results. Furthermore, there is a risk of social desirability bias, particularly considering the potential for using ChatGPT as an academic cheating tool. To delve deeper into this issue, future research should employ a combination of qualitative and quantitative methods for both students and professors.

Lastly, the rapid evolution of technology may render some findings less relevant over time. Currently, many students and professors may not fully grasp the possibilities offered by AI, and institutions may lack comprehensive strategies for addressing academic integrity concerns related to AI. However, AI will become more integrated into higher education as an additional educational tool. Therefore, conducting longitudinal research at regular intervals is recommended to track changes in attitudes and technology usage in higher education.

Conclusion, Implications, and Recommendations

Throughout history, the emergence of new technologies has consistently elicited both enthusiasm and resistance, from various, and sometimes the same, individuals. The latter seems to especially apply to the emergence of language models like ChatGPT, which many perceive as the greatest technological breakthrough since the advent of the internet.

Kelly, Sullivan, and McLaughlan (2023) examined news articles about the influence of ChatGPT on higher education and highlighted that the media focus was on academic integrity issues more frequently than educational opportunities. As the authors suggested, reading about ChatGPT mainly as a new tool for better cheating, more often than a possibility for better learning, can influence students' attitudes and behavior. A similar hype occurred in Croatian media. However, our findings suggest, most Croatian students still do not regularly use ChatGPT to complete their homework assignments, although, by the time of publication of this paper, we certainly expect an increase in its usage.

Currently, among regular users there are more male than female students, and more science and technology students compared to social sciences students. On average, students cite four main reasons for using ChatGPT in completing their homework assignments, among which the predominant ones are finding content that interests them, deeper analysis of a subject matter, and, in third place (with almost 50% frequency of selection), for writing textual assignments (essays, seminars, reviews, etc.). The latter can be considered unethical usage, especially if it involves uncritical copy-pasting. However, there is some hope in the findings, on the level of acceptability of using this tool in homework assignments, with the majority considering it to be unacceptable to literally copy more than half content (with gender differences once again noted in the same direction). Hopefully students mostly perceive it as an auxiliary tool, as it should be, and not a complete replacement for their own effort.

Our research shows that professors are almost powerless against such content, that is, they cannot accurately assess the authorship of the work – with the average accuracy rate of 53%. Even the fact that a particular professor teaches the course he/she is evaluating is not a guarantee of accuracy.

A mitigating circumstance for professors is that there will always be a proportion of easily detectable students, who are investing minimal effort even into plagiarism, delivering papers they did not edit or even read. Unfortunately, even they can easily be taught how to create highly convincing papers, just by slightly adjusting the prompt (e.g. “write a paper as if you were an average student”).

A major institutional challenge here will be managing the damage caused by all of those who consider plagiarism evidence of their resourcefulness, see no ethical problem in it, and even boast about it. When this becomes a common occurrence in a system, conscientious individuals perceive “distributive organizational injustice”. This becomes demotivating and leads to feelings of injustice, frustration, and loss of trust in the assessment system. Furthermore, it undermines fundamental principles of education such as honesty, integrity, and effort.

Professors play a significant role in how they will handle this relatively new situation – whether to deny the existence of a freely available version of the program that can produce work in seconds, which would otherwise take students days, or to clearly communicate to students the "elephant in the room" and institutionally formalize procedures for this.

The fact that students are mostly unsure of what professors know and can do regarding AI plagiarism detection (as seen in our data) leaves room for educational institutions to manipulate fear, at least until adequate software is developed that can more accurately detect plagiarism in AI-generated papers. Of course, a more ethical and sustainable solution in the long run is to focus on education and nurture, for example, the development of internalized beliefs that such behavior is inappropriate and unsustainable. Fostering a culture of integrity and respect for academic rules should be encouraged. Educational institutions need to have clear policies and procedures for detecting and penalizing academic dishonesty to ensure fair and equal

assessment of all students. This includes the necessity for clear guidelines, plagiarism detection tools, and educational initiatives to promote the ethical use of technology, specifically AI tools.

Acknowledgement

We would like to thank all the participants, especially the professors of VERN' University who participated in the workshop, and the students of the same institution, whose constructive contributions helped to compose the questionnaire used in the research. Acknowledgement should also be given to ChatGPT, which was used for creating materials for professors' survey, and for proofreading the text to improve its grammatical and linguistic accuracy.

References

Abdaljaleel M., Barakat, M., Alsanafi, M. et al. (2024). A multinational study on the factors influencing university students' attitudes and usage of ChatGPT. *Scientific Reports 14*(1), 1983. https://doi.org/10.1038/s41598-024-52549-8

Abdullah, F., and Ward, R. (2016). Developing a general extended technology acceptance model for E-learning (GETAMEL) by analysing commonly used external factors. *Computers in Human Behavior 56*, 238–256. https://doi.org/10.1016/j.chb.2015.11.036

Ajzen, I. (1991). The theory of planned behaviour, *Organizational Behaviour and Human Decision Process*, 50 (2), 179–212. https://doi.org/10.1016/0749-5978(91)90020-T

Basic, Z., Banovac, A., Kružić, I. & Jerković, I. (2023). ChatGPT-3.5 as writing assistance in students' essays. *Humanities and Social Sciences Communications, 10*(1). https://doi.org/10.1057/s41599-023-02269-7

Bouzar, A., El Idrissi, K., Ghourdou, T. (2024) Gender differences in perception and usage of ChatGPT, *International Journal of Humanities and Educational Research 6*(2), 571–582. https://doi.org/10.47832/2757-5403.25.32

Busch, P. A., & Hausvik, G. I. (2023). Too Good to Be True? An Empirical Study of ChatGPT Capabilities for Academic Writing and Implications for Academic Misconduct. *Paper presented at the Twenty-ninth Americas Conference on Information Systems*, Panama.

Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education, 20*(1), 1–25. https://doi.org/10.1186/s41239-023-00408-3

Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, *20*(1), 43. https://doi.org/10.1186/s41239-023-00411-8

Chiang, F.-K., Zhu, D., & Yu, W. (2022). A systematic review of academic dishonesty in online learning environments. *Journal of Computer Assisted Learning*, *38*(4), 907–928. https://doi.org/10.1111/jcal.12656

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008

DiPietro, M. (2010). 14: Theoretical frameworks for academic dishonesty. *To Improve the Academy, 28*(1), 250–262. https://doi.org/10.1002/j.2334-4822.2010.tb00606.x

Draxler, F., Buschek, D., Tavast, M., Hämäläinen, P., Schmidt, A., Kulshrestha, J., Welsch, R., (2023). Gender, Age, and Technology Education Influence the Adoption and Appropriation of LLMs. In Manuscript submitted to ACM. ACM, New York, NY, USA.

Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., … Wright, R. (2023). "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management, 71*. https://doi.org/10.1016/j.ijinfomgt.2023.102642

Farhi, F., Jeljeli, R., Aburezeq, I., Dweikat, F. F., Al-shami, S. A., & Slamene, R. (2023). Analyzing the students' views, concerns, and perceived ethics about ChatGPT usage. *Computers and Education: Artificial Intelligence*, *5*, 100180. https://doi.org/10.1016/j.caeai.2023.100180

Fleckenstein, J., Meyer, J., Jansen, T., Keller, S., Köller, O. & Möller, J. (2024). Do teachers spot AI? Evaluating the detectability of AI-generated texts among student essays. *Computers and Education: Artificial Intelligence*, *6*. https://doi.org/10.1016/j.caeai.2024.100209

Granić, A., & Marangunić, N. (2019). Technology acceptance model in educational context: A systematic literature review. *British Journal of Educational Technology*, *50*(5), 2572–2593. https://doi.org/10.1111/bjet.12864

Herbold, S., Hautli-Janisz, A., Heuer, U. et al. A large-scale comparison of human-written versus ChatGPT-generated essays. *Scientific Reports 13*, 18617. https://doi.org/10.1038/s41598-023-45644-9

Iqbal, N., Ahmed, H., & Azhar, K. A. (2022). Exploring teachers' attitudes towards using ChatGPT. *Global Journal for Management and Administrative Sciences 3*, 97–111. https://doi.org/10.46568/gjmas.v3i4.163

Jowarder, M. I. (2023). The Influence of ChatGPT on Social Science Students: Insights Drawn from Undergraduate Students in the United States. *Indonesian Journal of Innovation and Applied Sciences (IJIAS), 3*(2), 194–200. https://doi.org/10.47540/ijias.v3i2.878

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., … Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, 103, Article 102274. https://doi.org/10.1016/j.lindif.2023.102274

Kelly, A., Sullivan, M., & McLaughlan, P. (2023). ChatGPT in higher education: Considerations for academic integrity and student learning. *Journal of Applied Learning and Teaching, 6*(1). https://doi.org/10.37074/jalt.2023.6.1.17

Kiralj, R. (2020). Akademska čestitost studenata – preduvjet gospodarskog razvoja. *Radovi Zavoda za znanstvenoistraživački i umjetnički rad u Bjelovaru, 0*(14), 148–182. https://doi.org/10.21857/m3v76te4ny

Kiryakova, G.; Angelova, N. (2023) ChatGPT—A Challenging Tool for the University Professors in Their Teaching Practice. *Educational Science*, 13, 1056. https://doi.org/10.3390/educsci13101056

Liu, Y., Z. Zhang, W. Zhang, S. Yue, X. Zhao, X. Cheng, Y. Zhang, and H. Hu. 2023. ArguGPT: Evaluating, Understanding and Identifying Argumentative Essays Generated by GPT Models. *arXiv preprint arXiv:2304.07666*; Retrieved from https://arxiv.org/abs/2304.07666.

Lozano, A.& Blanco Fontao, C. (2023). Is the education system prepared for the irruption of artificial intelligence? A study on the perceptions of students of primary education degree from a dual perspective: current pupils and future teachers. *Educational Science.* 13, 733. https://doi.org/10.3390/educsci13070733

Majstorović, D. (2016). Stavovi studenata korisnika Nacionalne i sveučilišne knjižnice u Zagrebu o plagiranju i javnoj objavi ocjenskih radova. *Vjesnik bibliotekara Hrvatske*, *59* (3–4), 131–152.

Memarian, B., & Doleck, T. (2023). ChatGPT in education: Methods, potentials and limitations. *Computers in Human Behavior: Artificial Humans, 1*(2), 100022. https://doi.org/10.1016/j.chbah.2023.100022

Miles, P. J., Campbell, M., & Ruxton, G. D. (2022). Why students cheat and how understanding this can help reduce the frequency of academic misconduct in higher education: A literature review. *Journal of Undergraduate Neuroscience Education, 20*(2), A150.

Nguyen, T. C. (2023). University Teachers' Perceptions of Using ChatGPT in Language Teaching and Assessment. In *Proceedings of the AsiaCALL International Conference 4*, 116–128. https://doi.org/10.54855/paic.2349

Obenza, B., Salvahan, A., Rios, A. N., Solo, A., Alburo, R. A., & Gabila, R. J. (2024). University Students' Perception and Use of ChatGPT: Generative Artificial Intelligence (AI) in Higher Education. *International Journal of Human Computing Studies, 5*(12), 5–18.

Pandan, M. V., & Lomibao, L. S. (2022). Integrity of Mathematics Classroom Assessment in the New Normal. American Journal of Educational Research, 10(5), 282–287.

Rahman, M. S., Sabbir, M. M., Zhang, D. J., Moral, I. H., & Hossain, G. M. S. (2023). Examining students' intention to use ChatGPT: Does trust matter? *Australasian Journal of Educational Technology, 39*(6), 51–71. https://doi.org/10.14742/ajet.8956

Rasul, T., Nair, S., Kalendra, D., Robin, M., de Oliveira Santini, F., Ladeira, W. J., ... & Heathcote, L. (2023). The role of ChatGPT in higher education: Benefits, challenges, and future research directions. *Journal of Applied Learning and Teaching*, *6*(1). https://doi.org/10.37074/jalt.2023.6.1.29

San Jose, A. E. (2022). Academic Integrity of Students during the COVID-19 Pandemic: A Mixed Method Analysis. European Journal of Education and Pedagogy, 3(4), 97–103. https://doi.org/10.24018/ejedu.2022.3.4.400

Shaengchart, Y. (2023). A conceptual review of TAM and ChatGPT usage intentions among higher education students. *Advance Knowledge for Executives, 2*(3), 1-7.

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education, 128,* 13–35. https://doi.org/10.1016/j.compedu.2018.09.009

Siregar, F. H., Hasmayni, B., & Lubis, A. H. (2023). The Analysis of ChatGPT Usage Impact on Learning Motivation among Scout Students. *International Journal of Research and Review, 10*(7), 632–638. https://doi.org/10.52403/ijrr.20230774

Sok, S., & Heng, K. (2023). ChatGPT for education and research: A review of benefits and risks. *SSRN 4378735*. https://doi.org/10.2139/ssrn.4378735

Sozon M, Mohammad Alkharabsheh O. H., Fong P. W. & Chuan S. B .(2024). Cheating and plagiarism in higher education institutions (HEIs): A literature review [awaiting peer review]. *F1000Research*, *13*, 788. https://doi.org/10.12688/f1000research.147140.1

Sukackė, V. (2019). Towards extending the original technology acceptance model (TAM) for a better understanding of educational technology adoption. *SOCIETY. INTEGRATION. EDUCATION. Proceedings of the International Scientific Conference*, *5*, 525–549. https://doi.org/10.17770/sie2019vol5.3798

Susnjak, T. (2022) ChatGPT: The End of Online Exam Integrity? *ArXiv Preprint ArXiv:2212.09292*.

von Garrel, J., & Mayer, J. (2023). Artificial Intelligence in studies—use of ChatGPT and AI-based tools among students in Germany. *Humanities and Social Sciences Communications, 10*, 1–9. https://doi.org/10.1057/s41599-023-02304-7

Venkatesh, V. and Davis, F. D. (2000) A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science, 46*, 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V. and Bala, H. (2008) Technology Acceptance Model 3 and a Research Agenda on Interventions, *Decision Sciences 39* (2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Waltzer, T., Cox, R. L., & Heyman, G. D. (2023). Testing the ability of teachers and students to differentiate between essays generated by ChatGPT and high school students. *Human Behavior and Emerging Technologies*, 1–9. https://doi.org/10.1155/2023/1923981

Waltzer, T., & Dahl, A. (2023). Why do students cheat? Perceptions, evaluations, and motivations. *Ethics & Behavior, 33*(2), 130–150. https://doi.org/10.1080/10508422.2022.2026775

Witmer, H., Johansson, J. (2015). Disciplinary action for academic dishonesty: does the student's gender matter? *Internation Journal of Educational Integrity, 11,* 6. https://doi.org/10.1007/s40979-015-0006-2

Zhang, Y., Yin H. & Zheng, L (2017): Investigating academic dishonesty among Chinese undergraduate students: does gender matter? *Assessment & Evaluation in Higher Education*. https://doi.org/10.1080/02602938.2017.1411467

Zhao, L., Mao, H., Compton, B. J., Peng, J., Fu, G., Fang, F., Heyman, G. D., & Lee, K. (2022). Academic dishonesty and its relations to Peer cheating and culture: A meta-analysis of the perceived peer cheating effect. *Educational Research Review, 36*, 100455. https://doi.org/10.1016/j.edurev.2022.100455

Yeadon W, Inyang O, Mizouri A et al. (2023) The death of the short-form physics essay in the coming AI revolution. *Physics Education 58*(3), 035027. https://doi.org/10.1088/1361-6552/acc5cf

Yilmaz, H., Maxutov, S., Baitekov, A., & Balta, N. (2023). Student attitudes towards chatGPT: A technology acceptance Model survey. *International Educational Review*, *1*(1), 57–83. https://doi.org/10.58693/ier.114

Corresponding author: Irena Miljkovic Krecar
Email: irena.miljkovic@vern.hr

Appendix A

Exploratory Factor Analysis of Attitude Towards ChatGPT Usage in Education Scale

Items	F1	F2	F3	F4
For tasks I don't have time for, I plan to use ChatGPT to do them for me.	.85			
For tasks that are too difficult for me, I plan to use ChatGPT to do them for me.	.79			
For tasks that I find uninteresting or don't feel like doing, I plan to use ChatGPT to do them for me.	.76			
It's pointless to invest hours and days in writing a paper or assignment when ChatGPT can write it in seconds.	.73			
With frequent use of ChatGPT in seminar preparation, students will not be able to develop academic skills such as paraphrasing text, compiling various sources, or summarizing text.		.82		
With frequent use of ChatGPT, students will not be able to develop digital literacy skills (skills for finding, evaluating, and using information found on the internet).		.75		
By using ChatGPT for homework assignments, we negatively impact the development of critical thinking skills on the assignment topic.		.75		
If students don't invest time and effort in attempting to solve their assignments themselves, but instead simply rely on ChatGPT to do it for them, they won't be able to learn the material well.	-.33	.73		
ChatGPT is a reliable source of information for writing most homework assignments.			.81	
I trust the accuracy of the information provided by ChatGPT.			.75	
ChatGPT is easy to use for most student tasks.			.75	
It's easy to get ChatGPT to do what I want it to do.			.71	
Using ChatGPT for homework assignments promotes the development of students' computer literacy skills.				.80
Using ChatGPT for homework assignments fosters creativity.				.77
Using ChatGPT for homework tasks is fun and interesting.				.65
If ChatGPT is already freely available, I don't see why I wouldn't use it to help me write a paper or solve a task.				.54
Extraction Sums of Squared Loadings	5.19	2.70	1.35	1.22
% of Variance	32.44	16.86	8.42	7.59

Note. Principal Component Analysis, Oblimin with Kaiser Normalization. KMO=.85, Bartlett's Test of Sphericity (X^2=2285.61, p <.001).

Factor 1: Intention, Factor 2: Risks of Use Factor 3: Easy Reliable Use, Factor 4: Usefulness.

Appendix B

Exploratory Factor Analysis of Ethical Issues of Chatgpt Usage in Writing Assignments

Items	Factor loading
Using ChatGPT to complete homework assignments is ethically unacceptable to me.	0.85
The use of ChatGPT in writing assignments should be prohibited.	0.86
By using ChatGPT to write homework assignments, we compromise the ethical principles of studying.	0.82
I don't see an ethical issue in submitting to the professor a paper that was entirely or mostly written by ChatGPT.	-0.54
Extraction Sums of Squared Loadings	2.42
% of Variance	60.39

Note. Principal Component Analysis. KMO=.75, Bartlett's Test of Sphericity (X^2=430.82, p <.001).

Developing a Course on Human-Centered Machine Learning-Based Product Design

Eui-Chul Jung
Seoul National University, South Korea

Meile Le
Hanyang University, South Korea

Abstract

Interpreting and incorporating machine learning technology from a human perspective helps define the role of product designers in the era of artificial intelligence. With this background, this study developed a 7-week design course about machine learning-based product design. Subsequently, in Fall 2023, a class with seven undergraduate students from different majors was held on the subject of "home camera." The design process consisted of (a) user research and need definition based on machine learning understanding and (b) machine learning-based interaction design development using a coding platform. The course was designed to explore the role of designers who implement human-centered design planning and prototypes considering machine learning tools. In addition, the course provided a basis for suggesting the direction of design education methods given emerging AI technology. The essence of design education is not merely about efficiency; rather, it is about nurturing designers' ability to think critically and use tools to cultivate innovation.

Keywords: design education, designer role, human-centered design, machine learning, ML product design course, product design

With the rapid advancement of technology, machine learning (ML) has become an indispensable tool for enhancing and optimizing user experience (UX) design of product use. ML applications are pervasive in our daily lives, whether through apps or online services. They perform various tasks, such as detecting and filtering spam, sorting or curating media feeds, predicting estimated driving times, converting speech to text, and auto-correcting typing errors. These applications significantly enhance the quality of interaction between users and technology, demonstrating the substantial potential of ML to improve interactive experiences.

Despite the advancements in technology, the market frequently encounters failures with ML-based products. Dove and colleagues (2017) criticized that developers and designers often use ML technology more as a marketing gimmick rather than a tool to address real user needs, a practice aptly described as 'putting lipstick on a pig.' Furthermore, the implementation of ML does not always enhance UX. Errors in prediction and opaque decision-making processes can lead to user frustration. For instance, overly personalized recommendation systems may confine users within 'filter bubbles' (Areeb et al., 2023), limiting their exposure to new and diverse content. Automated customer service systems often fall short of providing satisfactory solutions for complex or non-standard issues. The opaque 'black box' nature of these systems can erode user trust. More critically, ML systems have been shown to amplify social inequalities and biases (Holstein et al., 2019), exacerbating issues like gender bias and contradictions (Ahn et al., 2022). Such challenges include privacy violations, data biases, and broader issues of inequity, all of which pose hurdles in the UX design of ML-based products.

To address these challenges, product designers must move beyond the traditional foci on usability, utility, and interaction aesthetics towards more comprehensive design strategies. There is a pressing need to incorporate courses in design education that blend human-centered design thinking with ML to truly meet user needs. Significant research and curriculum development have already focused on the technical aspects of ML, such as those documented by Sulmont and colleagues (2019) and Munir and team (2022). However, as ML products increasingly encounter market bottlenecks and issues, more researchers are recognizing that the development of ML products should center more on human-centered design, not just technological innovation. Many studies, including those by Yang and colleagues (2021) and Riedl (2019), have analyzed the challenges ML products face from the perspectives of social ethics and user behavior psychology. Yet, from the standpoint of design education, the research and practice on how to educate future designers to comprehensively utilize ML technology in the design process while considering user needs are still very limited.

Therefore, this study proposed a human-centered product design planning and prototype creation course based on machine learning. The purpose of the course is to cultivate designers and developers who are more attentive to fulfilling actual user needs and enhancing UX when utilizing ML technologies. In this study, a mixed-methods approach was utilized to develop, implement, and evaluate the course. Our methodology focused on Course Development, starting with a comprehensive review of the existing courses, industry requirements, and the latest academic research. This initial analysis helped identify the key gaps and needs in the application of ML in UX design to ensure that the course incorporated the latest technological

advancements to address real-world challenges UX designers face. Based on the findings from the initial needs analysis, the course was structured as a seven-week program, segmented into four distinct modules: Problem Definition and Planning, Model Construction, Model Evaluation, and Implementation. Each module combined lectures with practical sessions, emphasizing real-world projects where students applied ML to tackle user-centric problems. Evaluation methods included student surveys and interviews to assess their understanding and the practical application of their skills. Feedback from industry stakeholders and long-term tracking of alumni will further inform the course's effectiveness and effects on professional practices.

Through a combination of theoretical learning and practical application, the course aims to enable students to effectively apply ML technologies in design practices while critically assessing and integrating these technologies to ensure that design solutions genuinely meet user expectations and needs.

Human-Considered Machine Learning Design Approaches

A lot of research has delved into how to use tools such as Midjourney in the discovery or development stage, which is the divergent stage of the design process that inspires the design concept (Chiou et al., 2023; Turchi et al., 2023; Zhang et al., 2023). However, due to the purpose-oriented nature of product design and the strong connection to human behavior, relying on interesting or unexpected accidental elements of the results generated by machine learning tools is insufficient. Particularly in the field of interaction design, which has intricate connections to human physiology and behavior, solutions are required that go beyond what image-generating tools can typically offer (Tholander & Jonsson, 2023). To use the machine learning tool more actively in the product design process, it is necessary to consider the curriculum for creation that can understand human needs and behaviors and solve problems.
Machine learning research often ignores human factors, such as usability, intuition, effort, and human learning, and focuses only on the efficiency of algorithms. However, human intervention is important for real-life applications. It is important to keep in mind that human values, goals, and social structures always play an important role in collecting training data, coordinating algorithms, and integrating machine learning into real-world systems. Human-centered machine learning is not a single approach but encompasses a wide diversity of problems, methods, technologies, and theories (Gillies et al., 2016).

However, many UX designers currently lack a deep understanding of artificial intelligence, which hampers their ability to effectively contribute to interdisciplinary teams during ML product development. UX designers may not fully grasp the dependent relationship of ML with data and ground truth. Some designers and commentators even treat ML as something magical (Dove et al., 2017). Researchers have found that practitioners without a background in AI face challenges in engaging with data and AI. Product professionals often struggle to understand what AI can do and find it difficult to translate business problems into data science problems (Piorkowski et al., 2021). This lack of designer involvement often leads ML products to emphasize technology at the expense of understanding user needs.

For ML product development, Stanford d. School's "Designing Machine Learning" course uses dimensions of idealism vs. realism and creativity vs. descriptiveness to categorize UX design into four stages: the Idealistic and Creative Crafting stage, the Idealistic and Descriptive Research stage, the Realistic and Creative Mapping stage, and the Realistic and Descriptive Monitoring stage. This framework highlights the unique challenges in machine learning-based UX product design compared to traditional UX design. In the Research stage, designers face the challenge of bridging the gap between theoretical research and practical application to effectively translate theoretical research into practical technologies or products. The Crafting stage deals with challenges in realizing innovative ideas as concrete products, particularly when technical or engineering support is insufficient. The Mapping stage involves addressing the opaque nature of machine learning systems and enhancing system transparency and interpretability to ensure that users can understand and trust these technological solutions. In the Monitoring stage, the challenge lies in overseeing the actual deployment of products and responding to potential system failures or performance declines to ensure continuity of the UX and system reliability.

Moreover, the design of intelligent systems also involves managing the dynamic relationship between user control and system automation. The challenge of integrating "intelligent" technology into people's lives or determining when automation is needed and when people desire a sense of control can be distilled into the debate between "do it for me" and "do it myself" automation (Koulu, 2020; Shneiderman & Maes, 1997). In machine learning (ML) systems, the relationship between user control and automation is often dynamic, influenced by user capabilities, their needs, and the capabilities of the ML system itself. Finding the optimal dynamic balance in a UX setting presents a significant challenge for designers (Berberian et al., 2012; Parasuraman et al., 2000). Designers must navigate these complexities to create experiences that effectively balance automation and user control, ensuring that systems enhance users' lives without overwhelming or alienating them.

Another major challenge faced by UX designers in the field of Machine Learning (ML) is its ethical implications (Dove et al., 2017). As machine learning technology increasingly affects many aspects of everyday life, UX designers must navigate the complex ethical landscape to ensure that these systems are designed responsibly. Ethical considerations in UX design affect not only user trust but also the broader social effects of the technology. This requires designers to address issues like data privacy, bias in algorithmic decision-making, and the transparency of ML systems during the UX design process.

Several initiatives and tools have been developed to address the challenges faced in designing machine learning systems centered on human needs and ethical values. People + AI Research (PAIR), an initiative in Google, is an approach to designing machine learning focused on humans (Google, 2019). According to Google, the aim of PAIR is "to explore the human side of AI by doing fundamental research, building tools, creating design frameworks, and working with various communities." This guidebook provides a series of articles outlining considerations for product development in AI: User Needs Defining Success, Data Collection Evaluation, Mental Models, Explainability Trust, Feedback Control, and Errors Graceful

Failure. Yildirim and colleagues' (2023) research revealed that practitioners use the guidebook not only to address AI's design challenges but also to improve education, cross-functional communication, and internal resources.

IDEO's AI Ethics Cards help guide an ethically responsible, culturally considerate, and humanistic approach to designing with data (Sampson & Chapman, 2019). The card set consists of four major design principles and ten activities intended to be used in teams working on the development of data-driven products and services. They help designers maintain a human-centered focus during the service or product development process.

Mathewson (2019) conducted an anthropocentric approach to interactive machine learning design as follows: (a) Define the hypothesis and state the investigated question of interest, (b) Loop in humans and define your values and principles, (c) Define the goal, (d) Define the data, (e) Build a model, (f) Evaluate the model, (g) Analyze trade-offs, and (h) Re-evaluate the model and iterate. Von Wangenheim and von Wangenheim (2021) explained the approaches in terms of the (a) needs identification and characterization of the context, (b) idea creation and specification of the intelligent system, (c) requirements analysis of the ML model, (d) data preparation, (e) model training and evaluation, (f) prediction, (g) model export, (h) model deployment, and (i) SW system test.

These frameworks and tools, as outlined in Table 1, offer a structured approach for integrating ethical considerations, user needs, and human factors into AI and ML system design, guiding curriculum development.

Table 1

Design Process for Human-Centered Machine Learning from Literature

Reference	Product Design Process for Human-Centered Machine Learning			
	Problem definition and planning	Model construction	Model evaluation	Implement
Stanford d.School (2018)	Researching	Crafting Mapping	Monitoring	
People + AI Research (2019)	User Needs Defining Success Mental Models	Data Collection Evaluation	Explainability Trust Feedback Control Errors Graceful Failure	
IDEO's AI Ethics Cards (2019)	Principles: Don't presume the desirability of AI Respect privacy and the collective good	Principles: Data is not truth	Principles: Unintended consequences of AI are opportunities for design	
Mathewson, K. W. (2019)	(a) Define the hypothesis State the investigated question of interest (b) Loop in humans Define your values and principles (c) Define the goal	(d) Define the data (e) Build model	(f) Evaluate model (g) Analyze trade-offs (h) Re-evaluate and iterate	
von Wangenheim & von Wangenheim (2021)	(a)Needs identification and characterization of the context (b) Idea creation and specification of the intelligent system (c) Requirements analysis of the ML model	(d) Data preparation (e) Model training	(e) Model evaluation (f) Prediction,	(g) Model export (h) Model deployment (i) SW system test

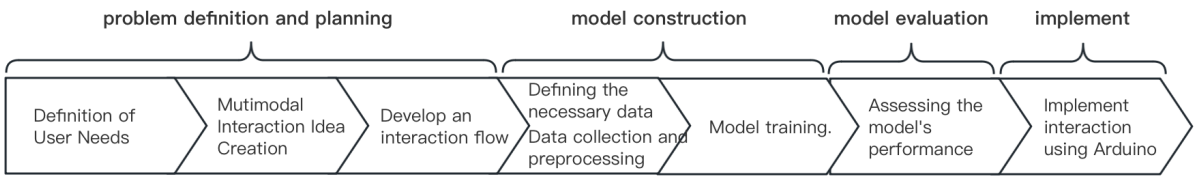
Core of Machine Learning-Based Product Design

Course Structure

Drawing from the studies outlined in Table 1, the product design process for human-centered machine learning can be segmented into four key stages: problem definition and planning, model construction, evaluation and implement. In the problem definition and planning stage, the following steps are included: (a) defining user needs, (b) generating ideas, and (c) creating an interaction flow to concretize ideas. The model construction stage encompasses (a) defining the necessary data, (b) collecting and preprocessing data, and (c) model training. The model evaluation stage involves assessing the model's performance through a confusion matrix and exploring methods to address errors. The following two steps, emphasizing multimodal interaction and implementing interaction using Arduino, have been added to improve the ability to design and implement a product from a human interaction perspective. Multimodal interaction is a key element of user-centered machine learning design that addresses diverse user groups, natural interaction, information richness, and flexibility in responses. The course follows the flow as depicted in Figure 1.

Figure 1

Product Design Course Structure Based on Design Process Sample



Phase 1: Definition of User Needs

The first phase of the course focused on human-centered machine learning solutions, and the emphasis was placed on equipping students with the necessary skills and insights to approach machine learning (ML) from a user-centric perspective. To effectively utilize machine learning to address real-world problems and create value, it is crucial to start from the user's perspective. Instead of asking whether machine learning can be used, designers should frame questions in terms of human-centered machine-learning solutions. When designing user-centered machine learning solutions, it is essential to first explore machine learning concepts and elements from a UX perspective, consider machine learning design within the context of UX, understand the process for structuring machine learning projects with UX in mind, and explore when artificial intelligence (machine learning) can yield effective results and when it might not be the best fit. The methodology for defining user needs involves three stages:

1. Listing Existing Evidence: Collect existing data, research findings, and information related to the issues and needs that users have encountered. This establishes a foundation for comprehending user requirements.
2. Detailed Description of User Needs: Utilize the gathered evidence to create a comprehensive and detailed description of user needs. This involves understanding what users desire, where they face difficulties and the specific problems they aim to solve.
3. Assessing the Potential Suitability of AI Solutions: Based on the existing evidence and the detailed description of user needs, evaluate whether machine learning-based solutions have the potential to effectively meet these needs.

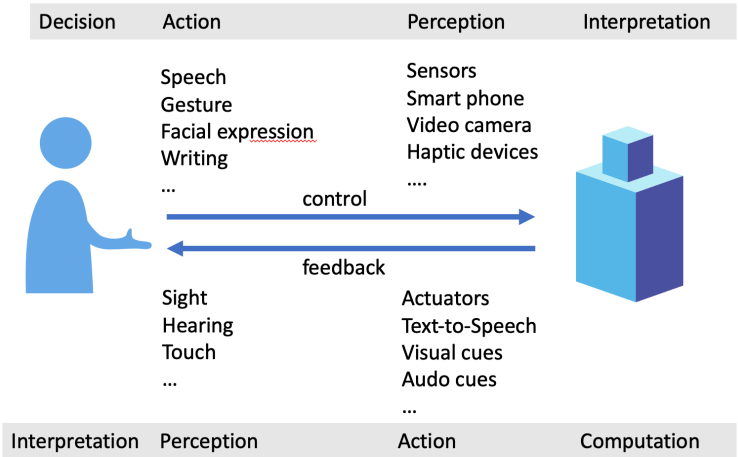
In this phase, when students are tasked with defining user needs in the context of machine learning projects, the focus shifts towards practical application and engagement with real-world problems through a user-centric lens. Understanding a user-centric standpoint and user needs is fundamental to creating successful machine-learning solutions that genuinely address user problems and enhance their experiences.

Phase 2: Multimodal Interaction Idea Creation

The second phase involved the practical application of combining machine learning with multimodal interaction to enhance UX and facilitate seamless interaction between physical and digital environments. Karray and colleagues (2008) argued that the interaction between human-machine systems fundamentally occurs through the exchange of information via various input and output methods between computers and humans. Hinckley and colleagues (2014) further elucidated the nature of these exchanges, highlighting that inputs to a system constitute the information relayed by the user to the machine. Conversely, system outputs are essentially the feedback provided to the user, which aids in navigating and accomplishing tasks. This dynamic exchange effectively bridges the gap between the internal operations of the system and the tangible, physical world, thereby facilitating a seamless interaction that spans the digital and physical realms. The multimodal human-machine interaction model is depicted in Figure 2.

Figure 2

Multimodal Human-Machine Interaction Model



Humans naturally engage in multimodal interactions with the world, utilizing various sensory channels to perceive and respond to other people and the external environment. Several studies (Bolarinwa et al., 2019; Mathewson, 2019; Xiao et al., 2003) have demonstrated that implementing multimodal interaction systems enhances flexibility and facilitates the exchange of information, allowing for natural and realistic interactions between intelligent systems and users. The combination of machine learning and multimodal interaction serves to improve the UX and enables more effective handling of interactions between physical and digital environments.

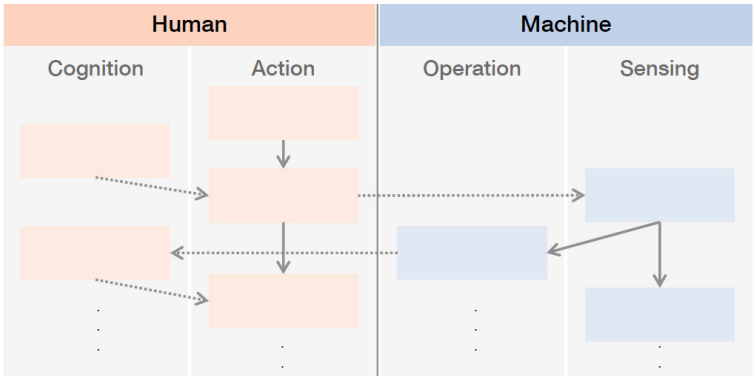
Therefore, in this phase, students were asked to critically examine the dynamics between data input and output in the context of machine learning tools guided by a human-centered perspective. This exploration was pivotal, as it required students to consider how users interact with machine learning systems and how these systems, in turn, respond to and guide user actions. The emphasis on a human-centered approach encouraged students to prioritize user needs, preferences, and behaviors in the design and development of machine learning applications.

Phase 3: Developing an Interaction Flow

In the third phase, students were asked to develop interaction flows for machine learning-based interactive products or systems. This phase emphasized the significance of understanding and designing products to enhance the dynamic relationship between humans and machine learning systems. Ghim (2021) highlighted that interactive products, unlike static products, possess two unique characteristics: human-machine interaction and temporal sequencing. For instance, users provide input to the product through physical actions and interpret the product's operation through mental processes.

Machine learning-based interactive products detect input through sensors, which can come from users or environmental changes, and respond through actuators or output components. The exchange of these actions and communications occurs sequentially over time to achieve the product's intended goals. Based on these two aspects, a framework can be established to help understand and design machine learning-based interactive products/systems, as shown in Figure 3.

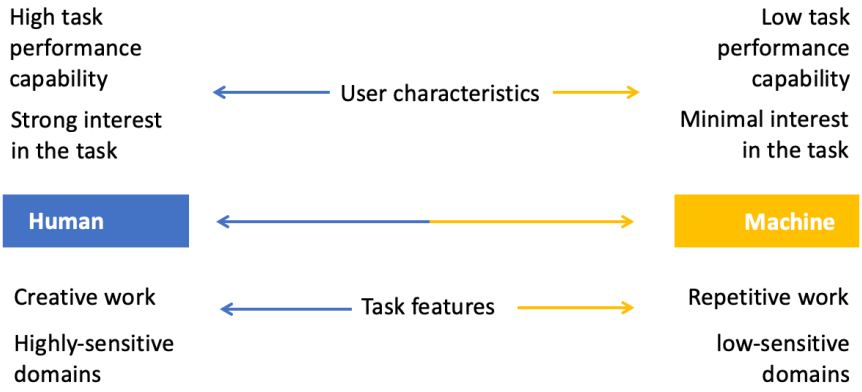
Figure 3
Human-Machine Interaction Flow



In machine learning interactions, the role of humans in the relationship between humans and machines varies depending on user characteristics, user needs, and task requirements. It is essential to consider the points at which the roles of humans and machine learning interchange based on the user's usage context. As shown in Figure 4, when users have a high level of task performance capability, a strong interest in the task, and engage in creative work or highly sensitive domains, machine learning interactions should be designed to enhance users' capabilities and creativity. In such cases, the machine learning system should play a supportive rather than a controlling role. On the contrary, when users have low task performance capability, minimal interest in the task, and engage in repetitive tasks or work in low-sensitive domains, machine learning interactions should be designed to simplify and automate tasks. The system should require minimal user input and decision-making, focusing on efficiency and reducing the cognitive load for the user. The machine learning system should take on a more proactive role, providing assistance, guidance, and automation to make the user's tasks easier and more manageable.

Figure 4

Changing Relationship Between Human and Machine Learning Based on User Characteristics and Task Features



Considering the fluid dynamics between humans and machine learning, as well as the intricate aspects of human-machine interaction and temporal sequencing, students were assigned the challenge of crafting interaction flows. These flows had to be tailored to meet the unique requirements and characteristics of both the users and their projects. This task emphasized the importance of understanding not just the technological capabilities of machine learning systems but also the human context in which these interactions occur.

Phase 4: Defining the Necessary Data and Data Preprocessing

Phase 4 emphasized the practical aspects of data handling for machine learning projects, specifically the collection, labeling, and preprocessing of data to meet user requirements. The process started with identifying the necessary dataset and then pinpointing the essential features and labels within this dataset that align with user needs. To enable machine-learning products to make accurate predictions, their underlying machine-learning models had to be trained based

on patterns and correlations within the data. This data, known as training data, could encompass a diverse range, including images, videos, text, and audio. Students could utilize existing data sources or collect new data specifically for training their system.

The quality of the training data, including how they were sourced, collected, and labeled, played a pivotal role in determining the output of the system. The quality, relevance, and accuracy of this data, rather than just quantity, were paramount. Properly labeled and well-structured data ensure that the machine learning model can learn effectively, leading to reliable and functional outputs. In addition to data collection, data preprocessing was an integral aspect of this phase. It involved cleaning the data, handling missing values, and standardizing or normalizing it for consistency. Preprocessing may also include transforming variables to make them more suitable for analysis. The goal of this step was to refine the data into a format that is conducive to training a high-performing machine learning model.

Through these tasks, students learned the critical role of high-quality, well-labeled, and properly processed data in building effective machine-learning systems. This phase not only enhanced their technical skills in handling data but also deepened their understanding of the foundational principles that govern the success of machine learning products, emphasizing the importance of meticulous preparation and analysis of data to meet user requirements.

Phase 5: Model Training

In Phase 5, students used a coding platform called Naver Entry to process the collected data and build machine-learning models based on that data. Naver Entry is an educational platform designed to foster computational thinking and provide hands-on experience with artificial intelligence features through a block-based interface. One of the key advantages of Naver Entry is its user-friendly interface, which is particularly accessible for design students with minimal programming background. Because of its ease of use, students could focus more on the application and implications of machine learning in their field rather than on the complexities of coding. Another key reason for choosing Naver Entry for model training in this phase was its adeptness in handling multimodal data, including images, audio, and text. This flexibility is crucial for a comprehensive learning experience and aligns well with the diverse nature of data typically encountered in real-world scenarios. It met the course requirements and provided students with practical experience in model training. Naver Entry allows users to train the models based on the following:

a. Image Classification: Train a model that can classify images uploaded or captured via a webcam.
b. Text Classification: Train a model capable of classifying text that you either write directly or upload as a file.
c. Voice Classification: Train a model that can classify voices recorded from a microphone or uploaded as audio files.
d. Numeric Classification: Train a model that classifies numeric data in tables into various classes based on the nearest neighbors (K-nearest neighbors) for each data point.

Phase 6: Assessing the Model's Performance

In the "Evaluation" phase, students delved into the critical process of assessing the performance of their machine learning models through the lens of a confusion matrix, a pivotal tool in understanding the nuances of model accuracy. The confusion matrix (Figure 5), also referred to as an error matrix, is a structured representation that showcases how well a classification model predicts outcomes across a set of test data, distinguishing between true positives (TP), true negatives (TN), false positives (FP), and false negatives (FN).

Figure 5

Confusion Matrix

		Predicted Condition	
		Positive	Negative
Actual Condition	Positive	True Positive(TP)	False Negative(FN)
	Negative	False Positive(FP)	True Negative(TN)

Note. True positive (TP): Observation predicted as positive is positive. False positive (FP): Observation predicted as positive is negative. True negative (TN): Observation predicted as negative is negative. False negative (FN): Observation predicted as negative is positive.

The effectiveness of a model is gauged by the magnitudes of TP and TN indicating correct predictions and the minimization of FP and FN signifying errors. The decision to either focus on reducing FP and FN or on maximizing TP and TN plays a significant role in shaping the user experience (UX), as noted by Davis and Goadrich (2006). This decision is not arbitrary but hinges on the specific goals of the machine learning application, the nature of the data, and the intended outcomes of the model.

When designing, the evaluation metrics vary based on the machine learning's purpose, data characteristics, and model objectives. For example, even for the same recommendation system, the important evaluation metrics can differ depending on the application. In product (advertisement) recommendations, high precision may be crucial because it increases the proportion of recommended products that are of interest to the user. Precision is important when leading to purchase actions. On the other hand, in music recommendations, high recall can help users explore and discover various types of music. Accordingly, music platforms should focus on increasing recall to assist users in finding diverse music and prevent churn.

In machine learning predictions, providing appropriate feedback to users when errors (FP/FN) occur is essential for maintaining user trust in the AI product. Feedback methods include notifying users of errors, explaining why those errors occurred, apologizing to users, soliciting

feedback from users to improve and adjust system performance based on user feedback, and providing options for AI intervention for more accurate results when necessary.

In this study, students were first asked to assess what should be emphasized in this task. For instance, in safety-related issues, one should focus on reducing the likelihood of FN (false negatives). In other words, extra attention should be paid to cases where a problem genuinely occurred but was not predicted by the machine learning model. With a match rate of 20-50% (an area with a high likelihood of false negatives occurring), they needed to consider how to provide feedback to users. They were required to outline how to request feedback from users and how to provide feedback to users in each situation, as shown in Figure 6.

Figure 6

Assessing the Model's Performance and Exploring Methods to Address Errors

Event	Match Rate	Prediction	Actual Condition	Confirmation	Feedback
	High (80~100%)	Positive	High probability of being Positive (TP)		
	Medium (50~80%) potential FP area		High probability of being Negative (FP)		
	Medium (20~50%) potential FN area	Negative	High probability of being Positive (FN)		
	Low (0~20%)		High probability of being Negative (TN)		

In each situation, students had to outline specific approaches for engaging with users, ensuring that the feedback loop is not only informative but also fosters trust and reliability in the machine learning application. By focusing on reducing false negatives or false positives and enhancing the dialogue between users and the system, students learned to create more resilient, responsive, and user-centric machine-learning solutions.

Phase 7: Implement Interaction Using Arduino

In Phase 7, the application of machine learning extended beyond theoretical concepts, merging with the physical world and tangible products. The key objective in this phase was to bring machine learning into real-life applications by employing Arduino. This phase reemphasized

the significance of multimodal interaction, focusing on the dynamic interplay between user input and system output, and integrated this with practical work using Arduino.

Students were tasked with exploring and prototyping various methods of user sensing and feedback. They used their machine-learning models in conjunction with Arduino to develop intelligent system prototypes. This process involved designing and building Arduino circuits, gaining a deep understanding of how inputs and outputs operate within the Arduino ecosystem, and coding these interactions to function as intended. This phase allowed students to test and validate their designs against user needs and requirements. It provided an opportunity to assess whether the prototypes meet the intended purposes and to understand the practical role of machine learning in actual product development.

By culminating the learning process with the development of a functioning prototype, students gained valuable insights into the practical applications of machine learning, understanding its role and potential in enhancing user interactions and experiences in the realm of physical products, thereby bridging the gap between theoretical knowledge and practical application.

Course Implementation and Evaluation

In the Fall Semester of 2023, a course was conducted with seven undergraduate students under the theme of 'home camera.' The group included four design majors, one education major, one life sciences major, and one marine engineering major. Except for the marine engineering student, who had some basic programming experience, the other students had no prior experience in coding. The students carried out various projects, including smart cameras for efficient study, Smile Boxes that help users maintain a positive mindset, pet-related products, and security-related products. The researchers aimed to assess the effectiveness of the course proposal by examining the student outcomes, focusing particularly on students who demonstrated the most fidelity to the machine learning-based product design process.

Student Project: Smart Home Camera for Pet Companionship

Many people consider their pets as part of their family. These individuals require more than simple observation; they need delicate care services. They want to provide appropriate support to their pets when they are alone, including observation, health monitoring, communication, provision of treats, and guiding their pets to specific areas.

One student defined the following design goals based on her experience of raising a pet and market research:

a. Real-Time Monitoring: Design that allows users to monitor their pets' status and activities in real-time and respond effectively.
b. Behavior Analysis: Functional design that uses machine learning to analyze pet behavior and notify the user.

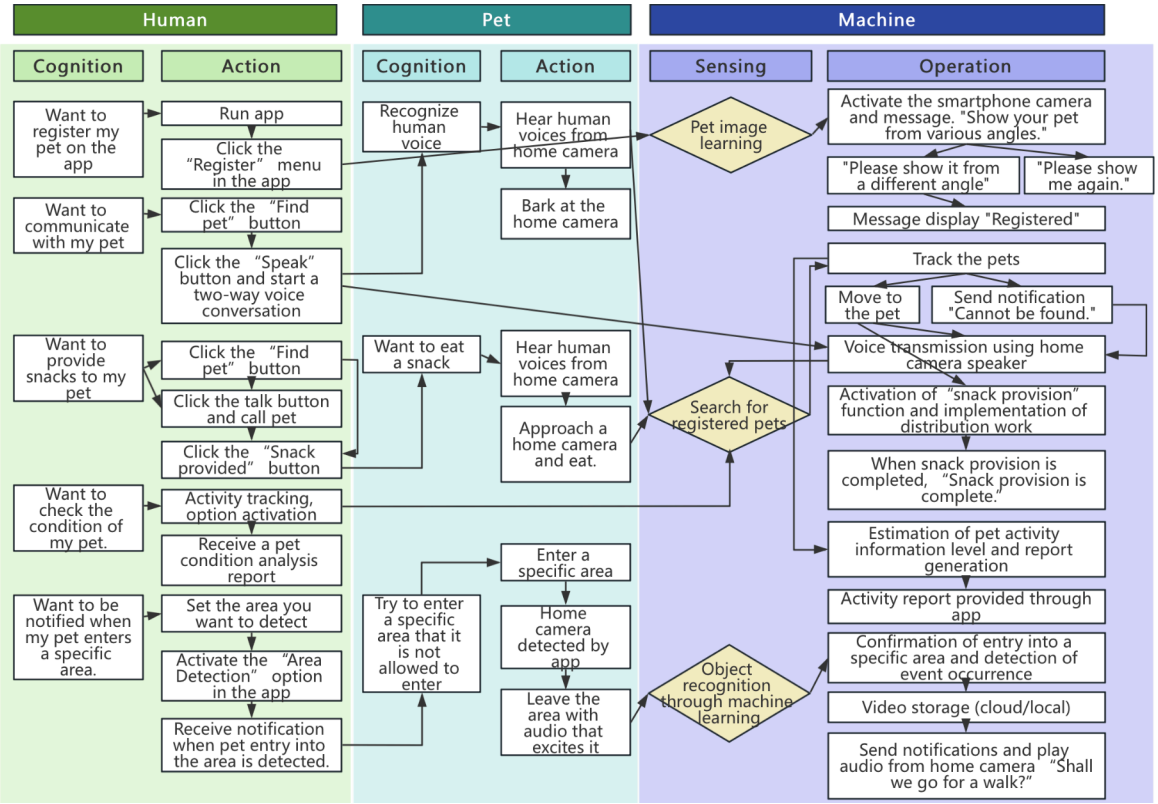
c. Enhanced Interaction: Design that enables bidirectional interaction between users and their pets through a smartphone app.
d. User-Friendly: Design that considers elements to minimize pet stress.

She ensured that machine learning solutions can be helpful in providing personalized services to users and aligning with the potential suitability of user needs for machine learning solutions. Based on the use needs, she created multimodal interaction ideas for providing an enhanced 'pet care service' experience Using Machine Learning:

a. Utilize machine learning to provide personalized services to users (e.g., tracking pet activity).
b. Process audio/video data based on learned patterns to send notifications only under specific conditions.
c. Detect and respond to user-defined events using machine learning (e.g., entering specific areas, behaviors like scratching food bowls).
d. Improve remote interaction between users and their pets (e.g., operating a speaker after tracking the pet).

Accordingly, the interaction flow, shown in Figure 7, was created. The interaction flow design should consider both the user's and the pet's actions to create a comprehensive UX. Since pets can also be users, the actions of pets are included in the flow.

Figure 7
Interaction Flow of Smart Home Camera for Pet Companionship



Then, she defined the data needed to train the machine-learning model: User and pet basic information data and user profiles, pet species, age, health status, behavior patterns, preference data, and audio/video data. Pet behavior data: Data related to a pet's entry into specific areas or specific behaviors. User feedback and interaction data: Data on interactions between users and pets, user feedback, and service usage records.

This student's work considered various user needs, including real-time monitoring, behavior analysis, enhanced interaction, and user-friendliness. The effectiveness of the project was evaluated based on the integration of machine learning features that aligned with the user needs and the comprehensiveness of the interaction design. The project was noted for its systematic approach and deep consideration of both user and pet perspectives within the interaction flow. The effectiveness of the student projects was assessed by examining how well the integration of machine learning features met actual user needs and the depth of the interaction design. This particular project was recognized for its systematic approach and thorough integration of both human and animal perspectives within the interaction flow.

Course Evaluation

During the 7-week class held in the Fall Semester of 2023 with seven students, meaningful advancements in understanding user needs for machine learning-based product design were observed. The students learned to reflect these needs consistently throughout the design process. Additionally, they gained insights into the design methods that utilize machine learning technologies appropriate for their selected project topics with the aid of "Entry," a block coding tool, which simplified the implementation of machine learning programs.

According to student evaluations, the class was beneficial as it provided them with opportunities to handle various AI-powered programs and apply machine learning to unfamiliar areas. Design students appreciated the way the course bridged the gap between creative design and technical implementation, allowing them to explore new dimensions in product design. Students from other majors valued the human-centered approach and AI understanding, noting that the problem-solving mindset gained from the course would benefit their future work by enabling innovative AI integration in their fields. However, they noted some challenges with remote delivery, including difficulties in performing practical exercises due to the limitations of virtual instruction. From the instructor's perspective, the class faced certain limitations. Primarily, the focus was on supervised learning techniques due to time limitations and the restrictions of the coding tools used, which narrowed the scope of AI applications. Additionally, the collected data often did not adequately reflect the users' actual situations and needs, leading to a deficiency in students' understanding of the data. Moreover, time constraints prevented the inclusion of product appearance and interface design in the curriculum.

Future iterations of the course should incorporate a broader array of machine learning technologies, including unsupervised learning techniques, such as clustering models and reinforcement learning. This expansion would enable students to apply their design skills in

more diverse real-world contexts. Additionally, the curriculum should be enhanced with more extensive data utilization, ensuring students can extract and model meaningful information effectively. These improvements will not only deepen students' understanding of machine learning applications in design but also increase their ability to use machine learning to address real user needs.

Conclusion

The rapid advancement of machine learning (ML) technologies brings with it a myriad of opportunities and challenges, particularly in the realm of UX design. While ML has the potential to significantly enhance interactions between users and technology, its practical implementation often falls short due to technological limitations, a general failure to meet real user needs effectively, and ethical concerns. This paper underscores the existing gaps in design education and practice, advocating for a shift towards more human-centered methodologies in developing ML-based products.

The newly proposed Machine Learning-Based Human-Centered Product Design Planning and Prototyping Course, structured as a seven-week program with four distinct modules—problem definition and planning, model construction, model evaluation, and implementation—aims to redress these educational shortcomings. This course weaves together a comprehensive review of existing courses, current industry demands, and recent academic research to meticulously equip future designers with the necessary skills to effectively utilize ML technologies while prioritizing user needs.

Feedback from the initial course, which included professional evaluations of student projects and student surveys and interviews, indicated that the curriculum could successfully bridge the gap between theoretical knowledge and practical application. Participants showed marked improvements in their ability to integrate ML technologies into their design practices, demonstrating a heightened sensitivity to user-centered design principles.

The continuous evolution of machine learning (ML) technologies will undoubtedly present new challenges and opportunities. Therefore, ongoing research, curriculum updates, and robust feedback mechanisms are crucial to ensure that educational offerings remain relevant and effective. It is necessary to continue to refine the modules proposed in the machine learning design education method. Furthermore, the findings from this course can serve as a foundational model for future developments in design education, particularly in integrating emerging technologies and user-focused design. Subsequent research should try to refine this approach into a comprehensive design education methodology—one that can foresee and understand the ensuing changes in consciousness, societal norms, cultural shifts, economic transitions, and the broader life evolutions they instigate.

The essence of design education is not merely about efficiency; rather, it is about nurturing designers' ability to think critically and use tools to cultivate innovation. Historically, photography was primarily approached from a technical perspective, aiming to capture subjects

effectively. However, it soon evolved into a revered art form. The transformative power of new technology on human life and culture is evident, particularly when considering how modern photography practices significantly influence our society and daily lives. As designers increasingly incorporate ML tools into their toolkit, it becomes crucial to reflect on their evolving role. These tools should be harnessed not just for efficiency but also for their ability to foster human-centric innovation, potentially leading to shifts in human consciousness.

Acknowledgements

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2021S1A5A2A01070316).

References

Ahn, J., Kim, J., & Sung, Y. (2022). The effect of gender stereotypes on artificial intelligence recommendations. *Journal of Business Research*, *141*, 50–59. https://doi.org/10.1016/j.jbusres.2021.12.007

Areeb, Q. M., Nadeem, M., Sohail, S. S., Imam, R., Doctor, F., Himeur, Y., ... & Amira, A. (2023). Filter bubbles in recommender systems: Fact or fallacy—A systematic review. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, 13*(f), e1512. https://doi.org/10.1002/widm.1512

Berberian, B., Sarrazin, J. C., Le Blaye, P., & Haggard, P. (2012). Automation technology and sense of control: a window on human agency. *PloS one, 7*(c), e34075. https://doi.org/10.1371/journal.pone.0034075

Bolarinwa, J., Eimontaite, I., Dogramadzi, S., Mitchell, T., & Caleb-Solly, P. (2019, June). The use of different feedback modalities and verbal collaboration in tele-robotic assistance. In *2019 IEEE International Symposium on Robotic and Sensors Environments (ROSE)* (pp. 1–8). IEEE. https://doi.org/10.1109/ROSE.2019.8790412

Chiou, L. Y., Hung, P. K., Liang, R. H., & Wang, C. T. (2023, July). Designing with AI: An Exploration of Co-Ideation with Image Generators. In *Proceedings of the 2023 ACM Designing Interactive Systems Conference* (pp. 1941–1954). https://doi.org/10.1145/3563657.3596001

Chmielewski, D., Hu, K. (2023). *Disney creates task force to explore AI and cut costs*. Reuters. Retrieved from https://www.reuters.com/technology/disney-creates-task-force-explore-ai-cut-costs-sources-2023-08-08/

Davis, J., & Goadrich, M. (2006, June). The relationship between Precision-Recall and ROC curves. In *Proceedings of the 23rd international conference on Machine learning* (pp. 233–240). https://doi.org/10.1145/1143844.1143874

Dove, G., Halskov, K., Forlizzi, J., & Zimmerman, J. (2017, May). UX design innovation: Challenges for working with machine learning as a design material. In *Proceedings of the 2017 chi conference on human factors in computing systems* (pp. 278–288). https://doi.org/10.1145/3025453.3025739

Ghim, Y. G. (2021). Allocated Flow Diagramming: A Structured Process and Methods for Teaching Interactive Product Prototyping in Industrial Design. *Archives of Design Research*, *34(d)*, 7–21. https://doi.org/10.15187/adr.2021.11.34.4.7

Gillies, M., Fiebrink, R., Tanaka, A., Garcia, J., Bevilacqua, F., Heloir, A., ... & Caramiaux, B. (2016, May). Human-centred machine learning. In *Proceedings of the 2016 CHI conference extended abstracts on human factors in computing systems* (pp. 3558–3565). https://doi.org/10.1145/2851581.2856492

Google (2019). *People + AI Guidebook*. Retrieved from https://pair.withgoogle.com/guidebook

Hinckley, K., Jacob, R. J., Ware, C., Wobbrock, J. O., & Wigdor, D. (2014). *Input/Output Devices and Interaction Techniques*. Chapman and Hall.

Holstein, K., Wortman Vaughan, J., Daumé III, H., Dudik, M., & Wallach, H. (2019, May). Improving fairness in machine learning systems: What do industry practitioners need?. In *Proceedings of the 2019 CHI conference on human factors in computing systems* (pp. 1–16). https://doi.org/10.1145/3290605.3300830

Karray, F., Alemzadeh, M., Abou Saleh, J., & Arab, M. N. (2008). Human-computer interaction: Overview on state of the art. *International journal on smart sensing and intelligent systems*, *1*(a), 137–159. https://doi.org/10.21307/ijssis-2017-283

Koulu, R. (2020). Human control over automation: EU policy and AI ethics. *Eur. J. Legal Stud., 12*, 9.

Mathewson, K. W. (2019). A human-centered approach to interactive machine learning. *arXiv preprint arXiv:1905.06289*. https://doi.org/10.48550/arXiv.1905.06289

Marq's Blog (2023). *Artificial Intelligence Design Tool Statistics & Trends in 2023*. Retrieved from https://www.marq.com/blog/artificial-intelligence-design-tool-statistics-trends-in-2023

Munir, H., Vogel, B., & Jacobsson, A. (2022). Artificial intelligence and machine learning approaches in digital education: A systematic revision. *Information*, *13(d)*, 203. https://doi.org/10.3390/info13040203

Parasuraman, R., Sheridan, T. B., & Wickens, C. D. (2000). A model for types and levels of human interaction with automation. *IEEE Transactions on systems, man, and cybernetics-Part A: Systems and Humans*, *30*(c), 286–297. https://doi.org/10.1109/3468.844354

Piorkowski, D., Park, S., Wang, A. Y., Wang, D., Muller, M., & Portnoy, F. (2021). How ai developers overcome communication challenges in a multidisciplinary team: A case study. *Proceedings of the ACM on Human-Computer Interaction*, *5*(CSCW1), 1–25. https://doi.org/10.1145/3449205

Riedl, M. O. (2019). Human-centered artificial intelligence and machine learning. *Human behavior and emerging technologies*, *1*(a), 33–36. https://doi.org/10.1002/hbe2.117

Roettgers, J. (2023). *Ikea's generative AI furniture designs are trippy, retro, and in-spiring*, FAST COMPANY. Retrieved from https://www.fastcompany.com/90871133/ikea-generative-ai-furniture-design

Sampson, O., Chapman, M. (2019). *AI NEEDS AN ETHICAL COMPASS. THIS TOOL CAN HELP*. IDEO. Retrieved from https://www.ideo.com/journal/ai-needs-an-ethical-compass-this-tool-can-help

Shneiderman, B., & Maes, P. (1997). Direct manipulation vs. interface agents. *interactions*, *4*(f), 42–61. https://doi.org/10.1145/267505.267514

Sulmont, E., Patitsas, E., & Cooperstock, J. R. (2019). What is hard about teaching machine learning to non-majors? Insights from classifying instructors' learning goals. *ACM Transactions on Computing Education (TOCE)*, *19*(d), 1–16. https://doi.org/10.1145/3336124

Tholander, J., & Jonsson, M. (2023, July). Design ideation with ai-sketching, thinking and talking with Generative Machine Learning Models. In *Proceedings of the 2023 ACM Designing Interactive Systems Conference* (pp. 1930–1940). https://doi.org/10.1145/3563657.3596014

Turchi, T., Carta, S., Ambrosini, L., & Malizia, A. (2023, May). Human-AI co-creation: evaluating the impact of large-scale text-to-image generative models on the creative process. In *International Symposium on End User Development* (pp. 35–51). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-34433-6_3

von Wangenheim, C. G., & von Wangenheim, A. (2021). *Overview on a human-centric interactive ML process for teaching ML in K-12.* Working Paper WP_GQS_01_2021_v10, GQS/INCoD/UFSC, Florianópolis, Brasil.

Xiao, B., Lunsford, R., Coulston, R., Wesson, M., & Oviatt, S. (2003, November). Modeling multimodal integration patterns and performance in seniors: Toward adaptive processing of individual differences. In *Proceedings of the 5th international conference on Multimodal interfaces* (pp. 265–272). https://doi.org/10.1145/958432.958480

Yang, S. J., Ogata, H., Matsui, T., & Chen, N. S. (2021). Human-centered artificial intelligence in education: Seeing the invisible through the visible. *Computers and Education: Artificial Intelligence*, 2, 100008. https://doi.org/10.1016/j.caeai.2021.100008

Yildirim, N., Pushkarna, M., Goyal, N., Wattenberg, M., & Viégas, F. (2023, April). Investigating how practitioners use human-ai guidelines: A case study on the people+ ai guidebook. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (pp. 1–13). https://doi.org/10.1145/3544548.3580900

Zhang, C., Wang, W., Pangaro, P., Martelaro, N., & Byrne, D. (2023, June). Generative Image AI Using Design Sketches as input: Opportunities and Challenges. In *Proceedings of the 15th Conference on Creativity and Cognition* (pp. 254–261). https://doi.org/10.1145/3591196.3596820

Corresponding author: Eui-Chui Jung
Email: jech@snu.ac.kr

Internationalized Students: Examining Students' Experiences in Virtual Study Abroad Programs in Japan

Ariunaa Enkhtur
Osaka University, Japan

Ming Li
Osaka University, Japan

Abstract

This paper explored students' experiences in an international virtual student mobility (VSM) program at a Japanese national university implemented in collaboration with partner universities in the Asia Pacific region and Europe. Through students' narratives, the study discerned how students perceive "mobility" and the concept of "international students" after participating in a virtual student mobility program. Findings revealed a tension between students' understanding of "mobility," official narratives, and students' actual experiences. While VSM programs facilitate communication and knowledge exchange across borders and develop cross-cultural communications, prevailing binary definitions in student mobility, such as "inbound" vs. "outbound," "domestic" vs. "international," or "study abroad" vs. "internationalization at home," limit VSM potential to be fully realized. This misalignment of the traditional understanding of student mobility that emphasizes place and borders challenges the official narrative of student mobility and urges educators to re-align and re-frame how we understand "international students."

Keywords: internationalization of higher education, Japan, students' perspectives, virtual student mobility

In Japan, driven by the goal to attract top international talent, compete with leading economic powers in research and innovation, and bolster its global status in education and industry, the government has been steering the internationalization of higher education (e.g., Yonezawa, 2014). Japan's unique challenges, such as an aging society; declining birth rate and college student population; and increasing pressure on higher education for talented graduates to revitalize the economy, have further propelled this push for internationalization (Ota, 2018; Yonezawa, 2014). Consequently, the government has been funding universities to "internationalize," establish overseas centers, develop English-taught programs targeting international talent, and encourage domestic students to study abroad.

These policies resulted in a significant rise in international students in Japan. In 2019, Japan hosted 312,214 international students, marking a fourfold increase in ten years since 1999 (JASSO, 2019), accounting for 5% of mobile students (UNESCO Institute for Statistics (UIS) database, 2023). However, as of 2023, 93% of these international students are from Asia, with almost half of them (45%) from China (JASSO, 2023). Official documents highlight the importance of attracting "diverse" international students, but the number-driven approach has led universities to focus on achieving the target number of students who can be classified as "international students" (Ota, 2018; Yonezawa, 2021). The legal definition of "international students" excludes those on short-term exchange programs under three months, thereby directing universities towards longer programs.

On the other hand, most domestic students do not participate in study abroad programs. In 2019, 107,346 students from total 2.9 million university students studied overseas, with 70% studying in under 1 month and 35% of students choosing one of three English-speaking countries—the US, Australia, and Canada (JASSO, 2021). Financial constraints, lengthy job-hunting processes, perceived lack of language skills are the main reasons for the lack of motivation to study abroad (Yokota et al., 2018). In this context, collaborative online international learning (COIL) and similar online programs have been introduced in Japanese higher education institutions, as part of educational programs to enhance students' language skills or intercultural communication skills, and often as part of pedagogical tools or "internationalization at home" initiatives (Hofmeyr, 2021).

The pandemic prompted Japanese universities to experiment with virtual mobility programs, as an emergency response to overcome border closures (Enkhtur et al., 2023; Shimmi et al., 2021). Following the pandemic, the government narrative also acknowledges ICT-based internationalization as reflected in Ministry of Education's J-MIRAI project discourse on international student exchange until 2033 (MEXT, 2021). Introducing the new internationalization plan, the document states, "as higher education progresses towards a hybrid model that combines face-to-face instruction with remote and online education, it is necessary to come up with new innovations in studying abroad, taking into account these trends" (MEXT, 2021, p.3).

Another example is the introduction of an online-mediated program platform "Japan Forum for Internationalization of Universities" (JFIU) under the government-funded Top Global

University project to promote Japanese universities overseas and to attract international students (Saito, 2022). Given the limited diversity among international students and the significant number of domestic students who remain immobile, virtual exchange models appeal to universities (MEXT, 2020). Yet, the prevailing narrative on "student mobility" remains anchored in physical mobility, continuing to use the binary descriptions like "outbound" versus "inbound" or "study abroad" versus "internationalization at home." In this paper, we explore students' lived experiences in international virtual exchange programs implemented at a top national university in Japan to challenge this existing narrative.

Literature Review

In recent years, the concept of student mobility has undergone significant transformation, particularly with the advent of virtual and hybrid models that emerged during the COVID-19 pandemic. These developments have prompted a re-evaluation of traditional approaches to international education, highlighting the need for a deeper understanding of how virtual student mobility (VSM) can complement or even substitute physical mobility. This literature review explores the existing research on VSM, focusing on its definitions, implementations, and the broader implications for global higher education.

Virtual Student Mobility

The UNESCO's report defined "virtual student mobility" as "a form of mobility that uses information and communication technologies to facilitate cross-border and/or interinstitutional academic, cultural, and experiential exchanges and collaboration" (UNESCO IESALC, 2022: 6). Drawing on 14 global cases, the report underscored the potential of VSM programs in post-pandemic landscape of global higher education to broaden access to student mobility "through virtual modalities." The report calls existing models of online exchange programs VSM, including "virtual exchange" and Collaborative Online International Learning (COIL), as long as the program has aims similar to "physical student mobility such as knowledge exchange, work experience in another country, and/or cultural immersion" (p.14). Conversely, Erasmus+ and other notable international education and exchanges use "virtual exchange" to denote programs focusing on "people-to-people activities that promote intercultural dialog and soft skills development," highlighting the learner interactions (Helm & van der Velden, 2020).

Research on virtual student mobility has grown as institutions and researchers evaluate and reflect on the educational programs introduced during the pandemic, exploring various aspects of VSM and their implications for education. Some studies emphasize the role of ICT in virtual mobility programs, describing them as "technology-mediated" (Lee et al., 2022) or "technology-enabled" (Giralt et al., 2022) exchanges. These emphasize the delivery of international exchange programs using technology, focusing on ICT and other online platforms as educational tools for connecting students and facilitating discussion and collaboration.

Other studies examine the outcome of virtual mobility programs, gauging students' or facilitators' satisfaction. For example, O'Dowd (2021) observed that virtual exchanges helped

students overcome stereotypes, boost their confidence in communicating in their second language (L2), and shift their perception of English from a mere academic subject to a communication tool. Another study by Fritz and Marchewka (2023) found that after participating in a four-week pilot virtual program, Japanese students developed new perspectives about themselves and their perceptions of their Polish counterparts when measured pre- and post-program.

The Stevens Initiative published reports from 2020 to 2023 based on programs carried out in the Middle East and North America. These reports cover initiatives in secondary schools as well as higher education institutions, shedding light on program types, learning outcomes, and overall impact. They found that students' "knowledge of other countries or cultures" increased (2020) and that these programs engaged more underrepresented students than traditional in-person exchange programs (2023).

While researchers continue to use different terminologies to describe virtual models, recent studies recognize these programs as a form of "mobility" or an "alternative form of student exchange delivering the same benefits as traditional student mobility" (Alami et al., 2022). In Japan, telecollaboration, tandem, or COIL programs existed for many years before COVID-19 (Akiyama & Cunningham, 2018). Yet, it was not until the pandemic, educational institutions integrated ICT into international education exchange (Ota et al., 2023). As universities adopted emergency virtual mobility programs, educators discovered the potential to engage a broader student base (Shimmi et al., 2021). For instance, one of the top national universities, Tohoku University, launched the "Be Global Project" consisting of online study abroad programs, intercultural collaboration learning programs, and virtual support and services for international students. The university called the initiative "a comprehensive initiative aimed at building a new international education model in post-pandemic international education" (Shimmi et al., 2021). Similarly, Enkhtur and colleagues' (2023) case study, a university attracted diverse students from different corners of the world to its online anniversary lecture series, where its prominent faculties delivered lectures.

Given the success and interest in these programs, and the rising adoption of digital technologies in educational institutions in Japan, researchers advocate for the continued implementation of VSM programs as a regular activity even after universities shift back to physical mobility (Enkhtur et al., 2023; Shimmi et al., 2021). A survey by the Ministry of Education, Culture, Sports, Science, and Technology in Japan (MEXT) revealed that top universities in Japan are inclined to develop blended and hybrid exchange programs post-pandemic (MEXT, 2020). Among universities participating in the Top Global University project, 86% expressed intent to develop blended/hybrid international mobility programs.

Additionally, the government is supporting initiatives for increased virtual education programs. For example, a new project, "Japan Forum for Internationalization of Universities" (JFIU), was established in 2021 by MEXT. Its mission is to strengthen the internationalization activities of leading Japanese universities through increased use of ICT (JFIU, n.d; Sato, 2022). Within this overarching project are several sub-projects by member universities. One of the projects led by

Tsukuba University has set up a so called “Japan Virtual (JV) Campus,” an online platform featuring contents and lectures from participating universities to promote Japan as the destination country for international education. In this context, while the official discourses on student mobility are shifting to include online modalities, they are still about physical mobility in Japan.

Student Mobility in Japan

In 1983, the Japanese government established its first target number for international students to increase to 100,000, aiming to recruit Japanese-speaking students (MIC, 2005). Then, in 2008, the government introduced its next target to increase international students to 300,000 by 2020. This increase was expected to foster an international environment, stimulate the stagnating economy, and elevate Japan’s global competitiveness (Yonezawa, 2011). To facilitate this growth, attract “talented” students worldwide, and “internationalize” the top domestic universities, the government introduced several initiatives, such as the Global 30 project from 2009–2014 and Top Global Project from 2014-2024, aiming to create an academic environment more appealing for international students.

In parallel, the government, in its goal to cultivate individuals capable of functioning within the global labor market (referred to as “global jinzai”), has also set targets for “outbound” mobility (Cabinet Office, 2014). The initial goal was to have 120,000 domestic students participate in outbound studying abroad programs by 2020. In pursuit of this target, the government introduced the “Tobitate! (Leap for Tomorrow) Study Abroad Initiative” aimed at incentivizing and providing assistance to domestic students to study abroad. The number of Japanese students studying abroad in 2019 reached 107,346; however, due to the disruptive impact of the COVID-19 pandemic, this figure plummeted to a mere 1,487 in 2020 (JASSO, 2020 & 2021).

However, these initiatives have emphasized quantitative results over the quality of programs which is evident in institutional strategies focusing on increasing international students, expanding study abroad programs, and institutional agreements (Ishikawa, 2011; Yamamoto, 2018). Regrettably, little attention has been paid to understanding students’ actual experiences or assessing the outcomes of these programs.

A review of these policies and projects indicates that the Japanese government’s policy for internationalization and student mobility emphasizes physical student mobility, counting students who enter the country. Official documents define “international students” as “foreign students enrolled in Japanese higher education institutions (universities, graduate schools, junior colleges, technical colleges, and vocational colleges) under the status of "College Student" as defined in Appendix 1 of the Immigration Control and Refugee Recognition Act” (MEXT, 2008). The “college student” visa, however, applies to students studying in Japan for a duration of more than 3 months but less than four years and 3 months (MOFA, 2023). On the other hand, universities count students who participate in not only curricular programs but also co/extra-curricular programs such as cultural expeditions (Kuroda et al., 2018) regardless of

their study period in outbound mobility. This includes students participating in study abroad programs based on university exchange agreements (MEXT, 2023).

Similarly, research on student mobility in Japan has focused on physical mobility, examining mobility trends (e.g., Kuroda et al., 2018), student motivations for studying abroad (e.g., Haupt et al., 2021), and aspects like adjustment, integration, and various social, academic, cultural experiences in Japan (Sato, 2016). On the other hand, research on virtual exchange students situates their studies within the "internationalization of higher education" theme, such as the internationalization of curriculum (e.g., Hammond & Radjai, 2022) aimed at improving domestic students' language and communication skills. While these programs may involve both foreign or domestic students joining from the host university or overseas, the existing binary understanding of "international" or "domestic" students exclude the students in virtual mobility programs.

In recent official documents by the Ministry of Education, however, virtual student mobility is acknowledged or encouraged, even after the pandemic. For example, the JV-Campus project noted that it "will increase the number of participating institutions from Japan and abroad, enrich and expand the contents we provide, including programs related to the Japanese language and culture, and establish new international exchange programs utilizing the online platform" (MEXT, 2022). Another MEXT document considering student mobility after the Top Global University project ends in 2024 mentions, "as hybrid education that combines face-to-face classes and distance/online education is progressing in higher education as a whole, it is necessary to make innovations in studying abroad in light of this trend" (MEXT, 2023).

However, at the same time, the government announced that it is considering setting up another target number for student mobility—to increase inbound international students to 400,000 and outbound domestic students to 500,000 by 2023 (J-MIRAI, 2023). The target emphasizes physical mobility as Jitsu ryūgaku or "authentic or actual study abroad." This was highlighted in the MEXT document:

> Excellent international students are accepted to study in Japan and provided with opportunities to receive education alongside Japanese students in Japanese society while also taking advantage of distance and online access. (MEXT, 2023)

Analysis of these documents shows tension and lack of clarity on what "student mobility" is and its value for Japan. While the documents call for the "reconsideration of study abroad" acknowledging virtual mobility, the virtual mobility programs are not perceived as a full-fledged program but more as a supplementary model to sustain or promote physical mobility.

In this unclear and shifting context, this paper explores virtual program students' understanding of "international students" and "study abroad" by asking a) how they define "international students" b) how they experience virtual programs and c) if their experience was similar or different from their imagined "international students" experience. By exploring the alternative

definition of "international students" through the lens of VSM students, we aim to reconceptualize and update the traditional and outdated notion of "international students."

Methodology

This qualitative study is based on discourses of students who have taken VSM course in 2022. The VSM program in this study was launched in the fall of 2021 at one of the leading national universities in Japan, under the term "Virtual Study Abroad" Program. Although the program was originally implemented to counter the pandemic restrictions on mobility, it continued after the pandemic, collaborating with more universities to share courses online in diverse disciplinary fields. On average, approximately 16 courses were mutually shared with 3-7 partner universities since then up until 2023, involving on average 72 students from overseas universities and approximately 23 students from the home university per semester.

Drawing on UNESCO's VSM survey (UNESCO, 2022), we administered a nonmandatory online questionnaire of virtual student mobility to students who participated in the university's Virtual Study Abroad program (VSM) at the end of each semester. The survey aimed to understand students' motivation for taking the course, satisfaction, challenges, and future expectations of study abroad experiences. It consisted of 54 items, four of which were optional open-ended questions. This study focuses on the qualitative responses for the open-ended questions that asked: "Why did you take this course?", "Please list specific incidents or events during the class you enjoyed.", and "Please suggest things that could be done differently." At the end of the survey, we asked whether they would allow the researchers to contact them for potential interviews about their experiences. 141 students answered the survey but 86 students responded to open-ended questions, and 20 students agreed to be contacted for further interviews.

In order to understand students' lived experiences in VSM courses and their general observations about their peers' experiences, we invited the students (n=20) who agreed to be contacted for potential interviews after completing the survey. After sending email invitations to each student with an interview consent form and interview protocol, 15 students accepted our request and scheduled online interviews via Zoom meeting. The interview protocol consisted of three main parts with opening and probing questions. First, to elaborate on survey responses, we asked about students' motivations for taking VSM courses and their previous experience in study abroad or online international programs. Then, we asked the participants about their understanding of the concepts of "study abroad" and "international students" and whether their experience in the virtual student mobility program aligned with their understanding. Finally, we asked the participants about their learning outcomes, whether their perspectives about themselves or the host or home country changed, and what they valued from the VSM learning experience. Interviews were conducted in English, Japanese, Chinese, or Mongolian depending on students' preference, and continued for approximately 1 hour.

Participants

In total, 141 students from over ten universities answered the survey over one year at the end of the spring, summer, and fall semesters in 2022. Out of them 86 students responded to open ended questions. For the purpose of this paper, we analyzed responses of these students to three open-ended questions. Of those who answered the open-ended questions, 58% (n=50) were female, and 42% (n=35) were male. By age group, 84% were 15-29 years old, and the rest, 16%, were above 30 years (4% per age group, 30-34, 35-39, and above 40). Over half of the participants (67%, n=58) were undergraduate, 19% (n=18) were master's level, 12% (n=10) were doctoral level students, and the rest (2%, n=2) indicated as "other." By field of study, 23% (n=20) of the participants were majoring in Arts & Humanities, 19% (n=16) in Medical Sciences and Social Sciences, and a few were in Computer Sciences (9%), Business & Management (8%), and Natural Sciences (6%). The majority of the respondents (64%, n=55) indicated they did not have any previous experience in taking virtual courses, while 32% (n=28) indicated they had (see Table 1). Twenty-five students (29) are students of the university we focused on, and the others are partner university students. Partner university students come from Hong Kong, China, Germany, New Zealand, and the Philippines.

Table 1
Characteristics of Participants

Characteristics	Questionnaire's respondents (86 respondents) number (percentage)	Semi structured interviews (15 interviewees) number (percentage)
Age, *Median*	20–24 (55)	25–29 (20)
Gender		
Female	50 (58)	10 (67)
Male	35 (42)	5 (33)
Current program level		
Undergraduate	58 (67)	7 (46)
Graduate	28 (33)	8 (53)
Field of study		
Arts & Humanities	20 (23)	3 (20)
Medical Sciences	16 (19)	2 (13)
Social Sciences	16 (19)	4 (27)
Engineering & Technology	13 (15)	2 (13)
Computer Sciences	8 (9)	2 (13)
Business & Management	7 (8)	1 (7)
Natural Sciences	5 (6)	1 (7)

The interviewed students came from 7 different countries, with 11 studying at Japanese universities (8 from the case university) and four at overseas universities. The majority of students were female (n=9) and graduate students (n=8).

Data Analysis

Drawing on the social phenomenological approach (Schutz, 1972), we aimed to understand students' overall experience in the VSM program in Japan or overseas. The responses to open-ended questions gave an overview of students' experiences in the program. The interview provided more detailed nuanced understanding of each student's experience. After analyzing the qualitative data from the survey, we developed the interview questions that aimed to understand each interviewee's experience during the interview. After transcribing the interviews, we summarized each student's experiences. We used students' descriptions and meanings they prescribed for their experiences during this process. We read each student's interview in full and described their experiences in our own words. For example, we wrote "the Japanese PhD student, participant 31, took … course as an opportunity to interact with overseas students. With her heavy research tasks and financial difficulties, she could not physically study abroad. The VSA program offered a chance to take a course that she was interested in from the comfort of her home…" The summaries helped us develop an overall picture of diverse student experiences, particularly when the interviews were conducted in different languages.

Then, we used a thematic analysis approach (Braun & Clarke, 2014) coding students' qualitative responses and interview transcripts separate from our summaries. We tried using students' own words during coding. For example, when a student said that they "felt abroad virtually" when they were describing their experiences abroad, we coded this description as "virtually abroad." Or when another student said he took the course for collecting local students' perspectives on his research topic, we coded it as "Motivation for VSM: For research." Then, two researchers worked together to apply categories for the codes, searching for overarching themes, and defining and naming the themes. The authors reviewed the themes in the context of literature and discussed them to reach a final consensus. We developed five main categories with 28 codes that included "motivations for taking the VSM courses" (information update, academic learning, research, job hunting etc.), "the learning experience in VSM" (e.g. academic, cultural, friendship, language), "short term outcome" (e.g. communication skills, cultural understanding, academic knowledge or other information, perspective change), as well as "meaning of study abroad" and an "access to international education." In reporting the results, we mainly quote interviewees' words as they provided more detailed answers. Only when indicated, the quotes are from the survey.

Results

VSM as a More Accessible Form of International Student Exchange

When asked about their motivation for taking virtual study abroad course, students in the survey mentioned that they wanted to expand academic or research knowledge by exploring academic content from other countries' perspectives and practices, to expand their understanding of other cultures and improve their cross-cultural communication skills and language skills. While for some students, the VSM program was a more convenient option,

saving the logistics of going through visa applications, reserving accommodation, and planning for academic and cultural activities, for some, it was the only possible option to get exposed to international education.

When we elaborated this during the interview, a Japanese PhD student said:

> "It would be difficult to study abroad because of my high amount of student loans. Thanks to this course, I realized that even if I couldn't go abroad, I don't need to give up learning with overseas students."

Another doctoral student from South Korea studying in Japan also said:

> "Because I am married and have family obligations, I would not have considered physically studying abroad. However, this course provided an opportunity to get valuable information about Chinese and Taiwanese family construction and cultural aspects, which was an important topic for my research."

These students did not consider physical study abroad programs for the financial burden and lengthy time commitment. For them, the VSM program provided access to international education overseas that they could not have otherwise afforded due to financial difficulties, family obligations, and other work and study responsibilities.

Furthermore, VSM was more convenient to participate in terms of logistics. A student from Germany said, "for this course, I don't need to take an intercontinental flight, which causes jetlag, CO2 and is difficult to fit into the schedule. If this course had not been offered as a virtual study abroad, I would not have taken it." While she viewed the VSM course as very important for her studies and employment, she did not consider traveling abroad only for taking this course.

The VSM program also provided opportunities to interact with foreign students. A master's student in Japan said:

> "We do not have any foreign students in my lab, so I don't have an opportunity to interact with foreign students…due to my research work and job hunting, I cannot afford to travel abroad during my master's program".

The majority of Japanese students do not have a chance to interact with foreign students outside foreign language classes (Morita, 2012). While English-medium programs in Japan have attracted a large number of foreign students, these programs are isolated from mainstream programs, and there is little interaction among students (Poole et al., 2020). Therefore, the VSM program in diverse disciplines makes it possible for Japanese students to take a class in their major without long-term commitment.

At the same time, because the program was more affordable and easier for students to participate in, some took the program to test the overseas university program or the learning environment before physically going there. In the survey, a Japanese student mentioned, "I want to go to China in the future, so I thought it was valuable to learn about China from Peking University, a top university in China." Another interviewee, a Chinese doctoral student studying in Japan as an international student said, "I'm graduating soon. I plan to work [teach at a university] back home [in China]. Therefore, I took the course before going there to make connections and see what it's like to be working [teaching] there." For this student, the VSM program was utilized to build social networks in the home country and prepare for the teaching profession in China.

Additionally, students took the VSM course to remain engaged in international exchange after participating in physical study abroad programs. A Japanese undergraduate student explained during the interview, "I took the course because it had lots of discussion components with foreign students. I wanted to improve or not forget my English skills after coming back from Australia." These findings illustrate that students taking the VSM program are diverse, and their experiences and motivations are multifaceted, from academic to practical reasons.

Finally, in the survey, a few students mentioned climate change or environmental pollution as an incentive to take the VSM model. While the student from Germany mentioned CO2 caused by air travel as one factor for avoiding the physical travel, another student who took an SDG course in China said:

> "The global aviation industry generates around 2.1% of all human-induced carbon dioxide (CO2) emissions. E-meetings, lectures, and conferences could effectively reduce CO2 emissions and at the same time enable virtual interactions between students from all around the globe".

While students in this study thought the VSM program is a more green and environmentally friendly form of exchange, it was not their top reason for choosing to participate in VSM. For the program participants, the reasons were rather related to being convenient and accessible.

Learning Experience: Mobility of Minds

Students' experience in the VSM programs varied due to different academic content, delivery types (e.g., whether it includes discussion sessions or not), or formats (e.g., length of the program). At the same time, some students said they were able to become completely immersed in the host university's academic course. A student from Germany said:

> "During the physical study abroad experience, we are often so overwhelmed by a new environment and need to take some time to adjust to the environment before actually starting to take in the academic contents or drawing on our reflections. However, the virtual course allowed me to just focus on the academic contents without worrying about things

> like adjustment because I joined the Japanese classroom and teaching style from the comfortable space of my home."

Similarly, during the interview, a student from Taiwan highlighted, 'VSM is best for learning new ideas. The program brought together top researchers from diverse fields, which is sometimes difficult to experience if you visit one professor's lab as a research student in Japan'.

Some of these students already had extensive overseas experience before participating in VSM programs. For them, the academic content was more important than building relationships or having cultural experiences. These students challenged underlying assumptions in international education in Japan that short-term exchange students seek mainly cultural experience or that physically being present in host country will have a positive learning experience. For example, a student from Germany further highlighted:

> "I know many students who did not make any Japanese friends or talked to any Japanese students while on study abroad program. So being in the environment does not always mean you get to have intercultural experience. Instead, during this kind of [VSM], you can take classes with Japanese students, interact with them, try to understand how they think etc\and then you go there…is better."

Students' experience also highlighted how VSM mobilizes students and encourages perspective transformation; thus, we call it "mobility of minds." While we expect VSM students to be moving from home to host, it can also be reversed from host to home. A Chinese student studying in Japan as an international student talked about her experience taking a VSM course from her home country in China. Although she was also a Chinese student, students in the class often approached her as an international student, mostly asking about her experience in Japan. Through class discussions and interactions with students in China, she could reflect on her mindset, values, and how she understood Chinese and Japanese society. She said:

> "I experienced education in China before, as I graduated as an undergraduate there, but this course gave me a chance to pull back and look at it [Chinese education] like from the third space. I could observe better and find things I have never seen before."

She also talked about her interaction with foreign students studying in China. These interactions with students in China while she is living in another country helped her revisit her old understandings and expand her perspectives about herself and her home country.

Another Japanese student viewed her experience as having "opened her eyes" to the Chinese culture:

> "I learned a lot about the university's academic culture, or the university structure based on how they organize their classes, and their rules…learned about what students were eating, cooking, and talking about by joining their chat group. I could follow their updates on WeChat Moments."

She compared this experience with her previous experience abroad, where she felt overwhelmed and could not participate in class or social activities as much as she wanted. She connected it with her being in a host country where the English language is the native language as well as the difficulty of navigating different new cultural and social expectations and the challenges to fit in. Compared to this experience, she did not need to feel accepted or form her own group of friends to be able to actively participate in class.

Overall, students talked about their exposure to different academic thoughts, expanding their networks through class and outside-class online activities such as WeChat or WhatsApp, practicing a foreign language, or gaining new perspectives about their perceptions. These students focused on interaction, communications, and perspectives change as a result of taking the VSM class.

"Student Mobility" and "International Student" through the Students' Eyes

When asked about their understanding of "study abroad" or "international students," students did not have a shared understanding. The majority of interviewees' understanding of "international students" was often around the technical definitions of having a visa of that country or being physically present in a foreign country. For example, a Mongolian student in Japan said:

> "I am an international student in Japan, and I do not think my experience of taking a course virtually from other countries equals my current experience. Therefore, I would not call my virtual experience a true "study abroad experience" because I am not physically there."

She talked about everyday life in a foreign country and interacting with citizens and neighbors as more important to the "international students" experience than "limited experience of talking to other students in a limited setting." Spontaneous interactions during everyday life and how they overcome new challenges are important for these students' international experience.

Several students said they would consider "international students" as those who are in an environment where they are not native speakers of that country, or they do not have citizenship of that country. These students considered "international students" as not necessarily being physically in a foreign country. A Japanese master's program student in Japan said 'I felt foreign, only my name was Japanese on the Zoom list, and the students in my class approached me on WeChat asking questions about student's life in Japan.' For these students, the VSM program provided "study abroad experience."

Another group of students who viewed their experience as "international" even though they did not travel abroad or talk in a foreign language. Some of them called it as "virtually being abroad." The VSM program had an international student studying in Japan who took an online course from her home university while doing her fieldwork overseas. We had Chinese students

studying in Japan taking an online course from China or German students taking a class in her native language from Japan. For example, the Chinese student said:

> "Although I probably do not match the definition of international student, I had an international mobility experience. I discussed with foreign students in China, I was able to expand and shift my perceptions about China, the Confucius philosophy."

For these students, the current definition of "inbound" or "outbound" or "study abroad" or "internationalization at home" cannot fully describe them or their experiences. This is problematic because it has wider implications for the support and services that VSM students receive in international exchange. A Mongolian student in Japan touched on this topic when she illustrated certain privileges associated with being labeled as an "international student." She said:

> "There can be extra support and services available for international students on campus, such as a tutor to help you adjust to the new culture. However, during the online exchange, we did not have such wide support available."

During the pandemic, due to the full stop of physical mobility, universities started using virtual modes as "mobility," counting students who join these programs and "study abroad," counting domestic students who take other universities' programs as outbound and vice versa. However, as physical mobility resumes, VSM students might not receive certain types of support services available to physically "inbound" or "outbound students." In this context, it is important to consider expanding the notion of "study abroad" or "international students" to be inclusive of programs such as VSM.

Given the above insights from the students, we believe that the term "internationalized" student is a more appropriate term, to describe students who participate in mobility. A Vietnamese student in Japan describes this necessity, "it doesn't matter where you study [physical mobility] or what language you use. What you learn as a result of this experience matters more." Another Chinese student said:

> "An internationalized student depends on whether there is a change in the way of thinking, whether there is an improvement in language skills, and whether there is a change in the way of looking at the world."

Thus, a term "internationalized students" shifts their focus to the outcome and quality of programs, while the more traditional term of "international students" focuses on the characteristics of students participating in the program (see table 2).

Table 2.
"International" vs "Internationalized Students" in Japanese Higher Education Context

	International students	Internationalized students
Description	"inbound" or "outbound" Students physically in a foreign country, often with a "student visa" studying for a certain period.	Students who have developed intercultural skills, more wider perspectives about themselves and the world as a result of participating in the international exchange, including VSM
Common measures	Quantitative: Counts students who participates in "study abroad" program	Qualitative: Evaluates students' learning outcome

Our study found discussions of "student mobility" parallel or diverging from more "traditional" discussions of mobility focused on "outbound" or "inbound" physical mobility. Some of the learning outcomes, skills, and networks the students participating in VSM develop are similar to "study abroad" programs, but the technical definitions of "international students" do not fully describe VSM students and their experiences. Instead, "internationalized" students would be a more appropriate term to describe VSM students, in the sense of their outcomes whose characteristics are more qualitative.

Discussion and Conclusions

In this paper, we explored virtual student mobility (VSM) from students' perspectives based on sample students who joined several VSM programs at a top national university in Japan and its partner universities. While Japan has been at the forefront of implementing virtual student mobility (VSM) programs in response to the COVID-19 pandemic, other countries have also explored similar models of international education. For example, in Europe, the Erasmus+ program has expanded its offerings to include virtual exchanges, focusing on fostering intercultural dialogue and soft skills development through technology-mediated interactions (Helm & van der Velden, 2020). In the United States, the Stevens Initiative has been instrumental in promoting virtual exchanges, particularly between students in the Middle East and North America, demonstrating the potential of VSM to increase access to international education for underrepresented student populations (Stevens Initiative, 2023).

These initiatives reflect a broader global trend toward integrating virtual components into traditional student mobility frameworks, thereby increasing the accessibility and inclusivity of international education. However, the adoption and integration of these models vary significantly across different educational contexts, influenced by factors such as technological infrastructure, institutional support, and cultural attitudes toward online learning.

As the internationalization of higher education in Japan is one of the national strategies to revitalize its economy, it has largely focused on student physical mobility. Until the COVID-19 pandemic, government initiatives focused on physical student mobility with little or no alternative digital provisions. While collaborative online learning programs (e.g., COIL, telecollaboration) were implemented to expose students to international education, they have not been considered "mobility" programs. However, our findings show that VSM programs are viewed as more accessible, convenient, green, and inclusive alternatives to physical mobility programs. Students chose this mode not only due to pandemic restrictions or post-COVID uncertainty but also because they could afford it—in terms of time, logistics, finances, or space. Furthermore, they did not need to cope with, as they described, a daunting physical experience of being in a foreign environment, or they were not ready yet to physically come to the host university. Therefore, most students wanted to have the VSM option open and available even after the pandemic.

In this sense, VSM has much more potential than being "supplementary" to physical mobility. VSM models have great potential to internationalize students and universities. As mentioned in EADTU (2010, p. 4), virtual mobility could be viewed not just as a tool to enhance physical mobility, but as an innovative and complete form of international mobility in its own right. It offers new and creative educational opportunities, allowing for the involvement of multiple international universities simultaneously, rather than being limited to just one host and one home institution, as is typically the case with physical mobility programs. Virtual mobility also provides more flexible study options that can be shorter in duration, less dependent on specific timeframes, and not tied to a particular location, offering students more personalized and specialized opportunities

The lack of physical change of space to different cultural and social environments meant that students could concentrate more on academic content or communication with instructors or peers without being distracted by the new environment. While students still needed to navigate online systems and different academic calendars, teaching styles, and expectations, they were less overwhelmed. Some students said they were more "equal" in the learning process because they were all "same," learning the same content without the need to feel accepted by the host students.

This more "neutral" space encouraged students to be more active in class, develop a new perspective and a more global mindset, and understand and accept different cultural backgrounds and values through the VSM program and their interaction with peer students during and after class. Students could also develop networks beyond the classroom based on social media groups and other platforms, without the shadow of being different and needing to feel accepted.

There were also students who were not interested in the cultural component of the "study abroad experience." While we often associate "study abroad" experience with "intercultural learning," some students in our study did not choose study abroad programs for intercultural learning purposes. Students who have studied in the host country before or who have developed

rich intercultural skills, or students specifically looking for academic or research content, were only interested in the academic or research part of the study abroad programs. For these students, virtual mobility programs may provide the information they seek in a more focused and condensed format. This sharing of knowledge fosters collaboration and communication across borders stepping up on cultural competencies, social networks developed.

Overall, students in VSM programs had more fluid experiences of mobility—mobility of knowledge and communication. Some students were joining the VSM program from home, while others were taking home institution classes from overseas while physically studying or traveling abroad. They do not fit in the current categorization of "inbound," "outbound," "study abroad," "internationalization at home initiatives," or "international students" that Japanese universities keep track of and get evaluated by in their goals of internationalization. However, this technical categorization and definition of "international student" matters because it entails different services and privileges for students as well as investment to other alternative types of internationalization. Focused on physical mobility, universities allocate staff and resources to help with inbound and outbound students. However, VSM students' experience and challenges show the danger of falling into the gray zone—not receiving support from either institution because they are not counted as either "inbound" or "outbound."

Although they may not be counted as "international students" based on the more traditional definition, some students nevertheless viewed their experience as "international" and that they have become more "internationalized" without crossing the border. As the VSM model is fluid and inclusive, and emphasizes students' learning outcomes over their physical experiences, the term "internationalized student" seems more appropriate to describe these students. In this sense, while the "international students" definition is more about students' characteristics (such as their visa status), the term "internationalized students" highlights the skills or knowledge students develop as a result of joining the programs. It therefore shifts the focus from the input and characteristics of students to the output, outcome, and the impact of mobility.

Suggestions for Future Research

Given the evolving landscape of global education, further research is needed to explore the long-term impacts of VSM programs on students' academic and personal development. Comparative studies that examine the effectiveness of VSM programs across different cultural and institutional contexts would provide valuable insights into the factors that contribute to successful virtual exchanges. Additionally, future research could investigate the role of VSM in promoting equity in higher education by making international learning opportunities accessible to a more diverse student population. By exploring these avenues, researchers can contribute to the ongoing dialogue about the future of international education in a post-pandemic world, helping to shape policies and practices that enhance the accessibility, inclusivity, and impact of student mobility programs globally.

Acknowledgements

We thank Dr. Xixi Zhang and Prof. Brendan Barrett for their contributions and advice on designing the original survey for the virtual study abroad courses that we adopted in this study. Also, we thank the international student affairs office for their assistance in distributing the survey to the students.

References

Akiyama, Y., & Cunningham, D. J. (2018). Synthesizing the practice of SCMC-based telecollaboration: A scoping review. *CALICO Journal*, *35*(1), 49–76. https://doi.org/10.1558/cj.33156

Alami, N. H., Albuquerque, J., Ashton, L. S., Elwood, J. A., Ewoodzie, K., Hauck, M., ... & Satar, M. (2022). Marginalization and underrepresentation in virtual exchange: Reasons and remedies. *Journal of International Students*, *12*(S3), 57–76. https://doi.org/10.32674/jis.v12iS3.4665

Bradford, A., Ishikura, Y., & Brown, H. (2022). Sustaining internationalization: English-medium programs in Japan. *International Higher Education*, (110), 15–16. Retrieved from https://ejournals.bc.edu/index.php/ihe/article/view/14981

Braun, V., & Clarke, V. (2014). What can "thematic analysis" offer health and wellbeing researchers?. *International Journal of Qualitative Studies on Health and Well-being*, *9*, 26152. https://doi.org/10.3402/qhw.v9.26152

Cabinet Office (2014). Wakamono no kaigai ryugaku sokushin jikkokeikaku [Action plan for promoting study abroad for young people]. Retrieved from https://www.cas.go.jp/jp/seisaku/ryuugaku/dai2/siryou2_2.pdf

EADTU (2010). *EPICS: New opportunities for international student mobility*. Retrieved from http://www.eadtu.eu/documents/Publications/VM/EPICS_New_Opportunities_For_International_Student_Mobility.pdf

Enkhtur, A., Li, M. & Zhang, X. (2023). Virtual student mobility from students' perspectives: Case study from Japan. *Higher Education Forum*, *20*, 59–78. https://doi.org/10.15027/538511

Fritz, R., & Marchewka, M. (2023). Transformative learning: Investigating perspective changes toward developing global human resources in a virtual exchange project. *Innovations in Education and Teaching International*, *61*(2), 370–384. https://doi.org/ 10.1080/14703297.2022.2163277

Giralt, M., Betts, A., Pittarello, S., & Stefanelli, C. (2022). Scenarios for the integration of virtual exchange in higher education. *Journal of International Students*, *12*(S3), 116–134. https://doi.org/10.32674/jis.v12iS3.4629

Hammond, C. D., & Radjai, L. (2022). Internationalization of curriculum in Japanese higher education: Blockers and enablers in English-medium instruction classrooms in the era of COVID-19. *Higher Education Forum*, *19*, 87–107.

Haupt, J. P., Sutrisno, A., & Hermawan, M. S. (2021). Motivations and outcomes in dual-degree programs: Insights from graduate scholarships for Indonesian civil servants. *Asia Pacific Education Review*, *22*, 535-548. https://doi.org/10.1007/s12564-021-09687-9

Helm, F., & van der Velden, B. (2020). Erasmus+ virtual exchange impact report 2019. *Publications Office of the European Union*. Retrieved from: https://data.europa.eu/doi/10.2797/513584

Hofmeyr, A. S. (2021). Rethinking the concept of global human resources in the Japanese higher education context. *Asia Pacific Journal of Education*, *43*(1), 62–78. https://doi.org/10.1080/02188791.2021.1889970

Ishikawa, M. (2011). Redefining internationalization in higher education: Global 30 and the making of global universities in Japan. In Willis, D. B., & Rappleye, J. (Eds.), *Reimagining Japanese education: Borders, transfers, circulations, and the comparative* (pp. 193–223). Symposium Books Ltd.

JASSO (2019). Result of an annual survey of international students in Japan 2018. Retrieved from https://www.studyinjapan.go.jp/en/statistics/zaiseki/data/2018.html

JASSO (2021). 2019 nendo nihonjin gakusei ryugaku jokyo chosakekka [Survey results of Japanese students studying abroad in 2019]. Retrieved from https://www.studyinjapan.go.jp/ja/_mt/2021/03/date2019n.pdf

JFIU (n.d.). *Japan Forum for Internationalization of Universities*. Retrieved from https://www.jfiu.jp/en/

J-MIRAI. (April 27, 2023). *Japan-mobility and internationalisation: Re-engaging and accelerating initiative for future generations*. Retrieved from https://www.cas.go.jp/jp/seisaku/kyouikumirai/pdf/230427jmirai.pdf

Kuroda, K., Sugimura, M., Kitamura, Y. & Asada, S. (2018). Internationalization of higher education and student mobility in Japan and Asia. *Global Education Monitoring Report*, Japan International Cooperation Agency and UNESCO. Retrieved from https://www.jica.go.jp/jica-ri/publication/other/l75nbg000010mg5u-att/Background_Kuroda.pdf

Lee, J., Leibowitz, J., & Rezek, J. (2022). The impact of international virtual exchange on participation in education abroad. *Journal of Studies in International Education*, *26*(2), 202–221. https://doi.org/10.1177/10283153211052777

MEXT (2008). Ryugakusei30mannin keikaku no kosshi torimatome no kangaekata [Concept of the 300,000 foreign students plan]. Retrieved from https://www.mext.go.jp/b_menu/shingi/chukyo/chukyo4/houkoku/attach/1249711.htm

MEXT (2020). Supagurobaru daigaku soseishien jigyo oyobi daigaku no sekaitenkairyoku kyoka jigyo saitakuko nitaisuru kinkyuanketo kekka no hokoku [Results of the emergency survey from universities in Top Global University project]. Retrieved from https://www.mext.go.jp/content/20200924-mxt_daigakuc03-000010089_5.pdf

MEXT (2021, June 25). Shingata korona o fumaeta aratana kokusai kyoiku koryu ni muke. [Towards a new international educational exchange considering the Covid-19]. Retrieved from https://www.nii.ac.jp/event/upload/20210625-03_MEXT.pdf

MEXT (2023). Gaikokujin ryugakusei zaisekijokyo chosa oyobi nihonjin no kaigairyugakushasu nado ni tsuite [Survey of international student enrollment and number of Japanese students studying abroad]. Retrieved from https://www.mext.go.jp/content/20230201-mext_kotokoku01-1412692_00003.pdf

MIC (2005). Ryugakusei no ukeire suishin shisaku ni kansuru seisakuhyokasho [Policy evaluation report on measures to promote the acceptance of international students]. Retrieved from https://www.soumu.go.jp/main_content/000250658.pdf

Morita, L. (2012). English and intercultural interaction in the internationalization of a Japanese university. *Journal of Intercultural Communication*, *12*(3), 1–07. https://doi.org/10.36923/jicc.v12i3.607

O'Dowd, R. (2021). What do students learn in virtual exchange? A qualitative content analysis of learning outcomes across multiple exchanges. International Journal of Educational Research, *109*, 101804. https://doi.org/10.1016/j.ijer.2021.101804

Ota, H. (2018). Internationalization of higher education: Global trends and Japan's challenges. *Educational Studies in Japan*, 12, 91–105. https://doi.org/10.7571/esjkyoiku.12.91

Ota, H., Shimmi, Y., & Hoshino, A. (2023, March 13-17). International education with ICT during COVID-19 Pandemic: Japanese Universities' Experiences [Conference presentation]. APAIE 2023, Bangkok, Thailand.

Poole, G., Ota, H., & Kawano, M. (2020). Tracing the developments of the "global education effect" in Japanese higher education: Discourses, policy, and practice. In Doerr, N. M. (Ed.), *The global education effect and Japan: Constructing new borders and identification practices* (pp. 33–60). https://doi.org/10.4324/9780429292064-3

Rumbley, L. E., Altbach, P. G., & Reisberg, L. (2012). Internationalization within the higher education context. In Deardorff, D. K., De Wit, H., & Heyl, J. D. (Eds.), *The SAGE handbook of international higher education* (pp. 3–26). https://doi.org/10.4135/9781452218397.n1

Sato, Y. (2016). Hi-kanjiken shusshin shihi ryugakusei no nizu to tokucho-Nihon gakusei shien kiko shihi ryugakusei seikatsu jittai chosa no bunseki kekka kara [Needs and characteristics of funded international students from non-kanji regions-based on the analysis of the living conditions survey by the Japan student services organization (JASSO)]. *Web Magazine Study Abroad Exchange*, *69*, 1–16. Retrieved from https://www.jasso.go.jp/ryugaku/related/kouryu/2016/__icsFiles/afieldfile/2021/02/18/201612ryugakukoryu.pdf

Sato, K. (2022). Shingatakorona wo fumaeta aratana kokusaikyoikukoryu ni mukete [Toward a new international educational exchange in light of the new coronavirus]. *IDE*, *638*, 4–9.

Schutz, A. (1972). *The Phenomenology of the Social World*. Northwestern university press.

Schweighofer, E. (1996). Teleteaching in the EU HUMANITIES project', BILETA'96 Conference Proceedings, 3. *The Journal of Information, Law and Technology*. Retrieved from http://www2.warwick.ac.uk/fac/soc/law/elj/jilt/1996_3/special/schweighofer

Shimmi, Y., Hoshino, A., & Ota, H. (2021). Posutokorona nimuketa kokusaikoryu: johotsushin gijutsu (ICT) wo katsuyo shita aratana kyoikujissen yori [International educational exchange and use of ICT in the post Covid 19 era: Emerging new practices]. *Web Magazine Study Abroad Exchange*, *120*, 26–41. Retrieved from https://www.jasso.go.jp/ryugaku/related/kouryu/2020/__icsFiles/afieldfile/2021/04/19/202103shimmihoshinoota_2.pdf

Stevens Initiatives (2020). *Virtual exchange impact and learning report*. Retrieved from https://www.stevensinitiative.org/resource/virtual-exchange-impact-and-learning-report-2/

Stevens Initiatives (2023). *Virtual exchange impact and learning report*. Retrieved from https://www.stevensinitiative.org/resource/2023-virtual-exchange-impact-and-learning-report/

UIS (2023). UNESCO Institute for Statistics (UIS) database. Extracted from http://data.uis.unesco.org

UNESCO IESALC (2022). *Moving minds: Opportunities and challenges for virtual student mobility in a post pandemic world*. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000380988

Yamamoto, B. A. (2018). The internationalization of Japanese higher education: Incremental change in a dynamic global environment. In: Yonezawa, A., Kitamura, Y., Yamamoto, B., & Tokunaga, T. (Eds.), *Japanese education in a global age*. *Education in the Asia-Pacific Region: Issues, concerns and prospects* (pp. 221–239). Springer, Singapore. https://doi.org/10.1007/978-981-13-1528-2_13

Yokota, M., Ota, H., & Shimmi, Y. (2018). *Kaigai ryugaku ga kyaria to jinsei ni ataeru impakuto:daikibo chosa niyoru ryugaku no kogasokutei* [Impact of study abroad on career development and life]. Tokyo: Gakubunnsha.

Yonezawa, A. (2011). The internationalization of Japanese higher education: Policy debates and realities. In Marginson, S., Kaur, S., & Sawir, E. (Eds.), *Higher education in the Asia-Pacific: Strategic Responses to Globalization*, *36*, 329–342. https://doi.org/10.1007/978-94-007-1500-4_17

Yonezawa, A. (2014). Japan's challenge of fostering "global human resources": Policy debates and practices. *Japan Labor Review*, *11*(2), 37-52. Retrieved from https://www.jil.go.jp/english/JLR/documents/2014/JLR42_all.pdf#page=39

Yonezawa, A. (2021). Reimaging university identities through rankings in Japan: The transformation of national policies and university behaviors in the broader East Asian context. In Hazelkorn, E., & Mihut, G. (Eds.), *Research Handbook on University Rankings*, 231–246). https://doi.org/10.4337/9781788974981.00027

Corresponding author: Ariunaa Enkhtur

Email: enkhtur.ariunaa.cgin@osaka-u.ac.jp

Using AI-Powered Speech Recognition Technology to Improve English Pronunciation and Speaking Skills

Nutprapha K. Dennis
Ubon Ratchathani Rajabhat University, Thailand

Abstract

This study aimed to investigate the impact of AI-powered Speech Recognition Technology (AI-SRT) in improving English pronunciation and speaking skills among EFL learners. Additionally, it explored the opinions and responses of EFL learners towards the use of this technology for pronunciation and speaking skill enhancement. The research employed a pre-test/post-test design and a survey questionnaire with a multiple-choice rating scale and open-ended questions. The study included a sample of EFL learners who received instruction and practice using an AI-SRT program over a designated period. Data were collected through pre-test and post-test assessments to measure changes in pronunciation and speaking skills. A survey questionnaire was administered to gather participants' opinions and responses regarding the program's effectiveness and their overall experience. The data were analyzed using descriptive statistics to examine the central tendency, variability and distribution of pre-test and post-test scores. Comparative analysis was conducted using paired t-tests to determine the significance of the improvement in pronunciation and speaking skills. Qualitative data from the survey questionnaire were analyzed thematically to identify recurring themes and patterns in participants' opinions. The findings of this study contribute to the understanding of the impact of AI-powered speech recognition technology on EFL learners' pronunciation and speaking skills. The results reveal the effectiveness of such technology and provide valuable insights into learners' perceptions and experiences. This research has implications for language educators, curriculum designers, and developers of educational technology in designing effective pronunciation and speaking skill enhancement tools for EFL learners.

Keywords: AI-powered speech recognition technology, EFL, English pronunciation, English speaking skills, pre-test/post-test design, survey questionnaire

Artificial intelligence (AI) is starting to revolutionize English pronunciation and speaking. AI-powered speech recognition technologies have shown potential in assisting students in improving their speaking skills. These programs, which are software applications or systems that employ AI algorithms and machine learning, convert spoken language into text. They are capable of analyzing and comprehending human speech, enabling devices or applications to respond to voice commands, transcribe audio recordings, or provide real-time, speech-to-text services.

While Speechling, Duolingo, and Google Assistant are prominent examples of AI-powered speech recognition technologies, it is important to explore additional alternatives to furnish learners with a diverse array of tools and resources (Garca-Sánchez, Soler-Urzúa, & Nussbaum, 2020). This study delves into various AI-powered speech recognition programs that are beneficial for improving English pronunciation and speaking abilities.

The use of AI technology has become more and more popular in language teaching. A significant number of studies have been done on how AI-powered speech recognition systems improve speaking and pronunciation. AI-based pronunciation feedback has been demonstrated by Garca-Sánchez and colleagues (2020) to enhance non-native English speakers' pronunciation. Similar increases in language learners' speaking fluency were observed by Zou and colleagues (2021) when they used AI-powered speech recognition.

The current study focuses on the implications of employing the Speechling program, an AI-powered speech recognition technology for English as a Foreign Language (EFL) learners, especially regarding pronunciation and speaking. Speechling is an online platform to help individuals improve their foreign language skills. The application uses artificial intelligence (AI) to deliver individualized pronunciation and fluency feedback. Learners can practice with actual human voices while recording sentences and receive expert guidance. It uses spaced repetition algorithms to improve language skills and is completely free.

The study aims to bridge the research gap by evaluating the effectiveness of AI-SRT in English pronunciation and speaking practice. Factors such as user-friendliness, program accuracy, feedback mechanisms, and additional functionalities will be explored. This inquiry will aid educators and students in selecting optimal tools for their requirements (Chen & Duan, 2020). Moreover, the study will explore the advantages and impact of speech recognition tools driven by AI. By broadening knowledge and comprehension of AI-SRT programs, students can make informed decisions in selecting the most suitable one for their personal learning objectives (Jia et al., 2019). Finally, this study seeks to empower language learners, educators, and researchers to harness AI technology effectively for practicing pronunciation and speaking skills. By evaluating AI-SRT programs for English improvement, learners can discover accessible language learning solutions tailored to their preferences. The ultimate goal is to assist students in achieving superior English speaking and pronunciation capabilities.

Conceptual Framework

The theoretical underpinnings of this research were grounded in well-established theories of language acquisition, second language learning, and computer-assisted language learning (CALL). To inform the design and implementation of AI-powered speech recognition technology (AI-SRT) programs for English pronunciation and speaking instruction, the study drew on Krashen's Input Hypothesis (Krashen, 1981) and Vygotsky's Sociocultural Theory (Vygotsky, 1934). These frameworks provided a robust theoretical base for understanding the cognitive and social dynamics of language learning and the advantages of integrating technology in language instruction. By incorporating these established theoretical perspectives, the study set a strong foundation for evaluating the effectiveness of the Speechling program and its impact on improving the pronunciation accuracy and speaking proficiency of language learners.

Background of the Study

Pronunciation and speaking present continual challenges for language learners, who have to navigate the complexities of linguistic and cultural integration to communicate accurately. The role of AI-powered speech recognition technology in language education has been a subject of interest, especially as it offers real-time feedback on pronunciation and speaking. Through the capabilities of machine learning and natural language processing, AI-SRT is able to pinpoint errors, mispronunciations, and areas in need of improvement within a learner's spoken language (Jia & Zhang, 2018). This advanced technology can facilitate personalized feedback, enabling tailored practice that enhances pronunciation, fluency, and overall speaking skills. Empirical evidence has suggested that AI-SRT could be instrumental in advancing language proficiency, with Computer-Assisted Pronunciation Training (CAPT) showing notable benefits for language learners (Jia & Zhang, 2018).

While existing studies yielded promising insights, there remains a need for further study into the application of AI-SRT in language learning. Additional study was essential to address potential limitations, refine its deployment, and verify its constructive contribution to language learning outcomes. This is important as its potency in augmenting pronunciation and speaking competencies for specific language functions has gained recognition in the realm of second language acquisition.

Moreover, the insights gleaned from such investigations have the potential to influence curriculum design and teaching methodologies. This study sought to delve into the influence of AI-SRT on the pronunciation and speaking abilities of language learners. Furthermore, it aimed to provide language educators and instructional designers with valuable guidance on how to effectively incorporate AI-powered tools in language education programs.

Statement of the Problem

The process of learning may have been impeded by limited access to high-quality learning tools and a shortage of experience between teachers with technology. These challenges may obstruct the effective practice of English pronunciation by EFL students. Therefore, the purpose of this study was to determine whether Speechling, an AI-powered speech recognition technology program, facilitated the accurate pronunciation of English by EFL learners. Furthermore, the study explored the manner in which EFL learners utilized an AI-SRT program to enhance their English pronunciation and speaking skills. This research supported educators in the implementation of a user-friendly and straightforward technology to enhance self-study, pronunciation, and speaking practice.

Research Questions

The study was designed to address two research questions:

1) What is the effectiveness of an AI-SRT program in enhancing EFL learners' English pronunciation and speaking abilities?
2) What are EFL learners' perceptions and responses to the use of AI-SRT for English pronunciation and speaking practice?

Purposes of the Study

This research is dedicated to exploring the potential benefits of utilizing an AI-powered speech recognition technology program to improve the English pronunciation and speaking proficiency of EFL students learning English. The study sets out to examine two principal areas.

The first area of focus is to assess the impact of the AI-SRT program on the participants' ability to enhance their English pronunciation and speaking skills. The research will employ systematic evaluation and in-depth analysis to determine the extent to which the AI-SRT program supports learners in the precise articulation of English words and phrases, as well as assesses its contribution to the overall advancement of their spoken language abilities.

The second aim is to explore EFL students' perceptions and reactions to the utilization of the AI-SRT program as a means to practice English pronunciation and speaking. By soliciting feedback from participants and conducting interviews and surveys, the study seeks to uncover learners' attitudes and opinions about the integration of AI-SRT technology into their language education. An understanding of their experiences will offer valuable insights into the program's receptiveness and the ease with which learners can engage with this educational technology.

Significance of the Study

This research expands the literature on using AI-powered speech recognition technology to improve English pronunciation and speaking for EFL learners. It aims to assist language instructors integrate such technologies into their teaching. The study will evaluate AI-SRT in language education to assist learners develop their language abilities without advanced learning resources. This study could further enhance English language instruction, improving communication between learners and native speakers. The study will examine AI-SRT's effectiveness for enhancing pronunciation and speaking skills, advancing English language learning. This could optimize language learning by using AI technology to improve teaching methods.

The findings could also assist curriculum developers develop more inclusive and adaptable learning materials for diverse learners. AI-SRT's practical benefits are demonstrated in the study to encourage policymakers to support the integration of advanced technologies in educational settings, which could lead to more language teaching innovation.

Literature Review

Importance of Pronunciation and Speaking Skills in Language Learning

Mastering pronunciation is essential for effective communication in a second language. Studies underscore the necessity of incorporating teaching of pronunciation, which includes elements such as individual sounds, intonation patterns, and speech flow, within language teaching programs to develop well-rounded oral abilities (Kang, 2016; Major, 2016).

Research conducted by Munro and Derwing (2016) and Saito and Lyster (2019) showed that phonetic training, activities that emphasize linguistic form, and constructive correction are key components in improving speech pronunciation. Furthermore, Thomson (2018) highlighted the need for dedicated instruction for educators in the art of teaching pronunciation, while also advocating for the integration of effective pronunciation instruction techniques into language education programs to aid in more successful language learning and oral proficiency.

Bohn and Munro (2020) delved into the difficulties that arise in learning how to pronounce words in a second language, shedding light on the obstacles students encounter and the targeted instruction needed to surmount them. Trofimovich and Isaacs (2019) argued for an increased emphasis on pronunciation within language teaching to enhance communicative skills. In addition, Zhang and Wei (2019) explored how second language acquisition, speaking abilities, and learner anxiety are interrelated, suggesting that fostering a relaxed learning environment can boost speech development. The collective findings of these studies make a compelling case that the role of pronunciation in language learning is pivotal, and requires personalized teaching strategies that build student confidence and skill. Recognizing the emotional aspects of language learning, such as anxiety, is also vital in crafting an educational setting that addresses personal learning hurdles and also advances overall language fluency.

Scholarly work emphasizes the importance of accurate pronunciation in second language acquisition and effective communication. To fully understand a language, teaching must account for sound subtleties, stress and intonation patterns, and speech flow. The relevance of these strategies across learning settings, and the ability to accommodate learners' diverse needs, such as native language influences, age, and unique cognitive approaches, vary and are subject to debate. Language teaching requires nurturing learning spaces and emotional support, as well as technical skills. Academics also want more pronunciation training for educators. Efforts to integrate pronunciation into academic curricula must be balanced against syllabus design, teaching materials, and educational institution strategy. Thus, while pronunciation is essential to language learning, its instruction requires overcoming logistical and learner-related obstacles.

Technology-Assisted Pronunciation and Speaking Training

Recent studies have shown a growing endorsement for the use of technology in the teaching of pronunciation and speaking skills for language learners. Research conducted by Morris (2020), Garca-Sánchez and colleagues (2020), and Liao and Xue (2019) have revealed the positive effects of artificial intelligence (AI) and Computer-Assisted Pronunciation Training (CAPT) in advancing learners' abilities to pronounce accurately and speak more proficiently. These technological tools, especially noted for their role in the betterment of vowel sounds and general spoken language performance, underscore the benefits of integrating digital aids into language education.

However, the success of technology-assisted pronunciation and speaking training is influenced by a variety of factors. Chen and Duan (2020) and Zou and colleagues (2021) highlighted the critical role of learner motivation, engagement, and individual learning differences in the efficacy of these programs. The literature suggests that learners' personal preferences and responses to training significantly shape the outcomes. Accordingly, CAPT programs that offer personalized feedback and adaptive learning experiences are recommended to cater to the diverse needs of learners. These adaptive features can optimize technology-assisted training by aligning with learners' attitudes, motivational levels, and specific requirements, thereby enhancing the overall effectiveness of such educational technology.

The literature reviewed herein supports using AI and CAPT to improve language learning pronunciation. However, a thorough analysis reveals that their efficacy depends on various factors. These factors include software quality, training program design, integration into comprehensive curricula, and adaptability to diverse learner needs and styles. Personalized systems require resources, and learners and instructors may have different technological skills. Although technology provides consistent feedback, it may lack the detail of human instructors. To improve language acquisition, technology-based language training must be carefully weighed against individual variations, learner attitudes, and instructor responsibilities.

AI-powered Speech Recognition Technology for Language Learning

Research examining AI-SRT suggests they offer substantial benefits for language learning. These technologies have been shown to enhance learners' pronunciation, fluency, and alleviate their anxiety towards language learning. For example, Li and Li (2021) affirmed that AI-driven language learning tools significantly improve pronunciation skills. Furthermore, Zhao et al., (2021) concluded in their meta-analysis that AI-assisted tools boost pronunciation precision, fluency, and reduce anxiety in individuals learning a second language. Yalcin and Korkmazgil (2021) discovered that an AI-infused mobile application markedly improved English pronunciation for EFL learners Kim (2019) observed that personalized AI-based pronunciation lessons notably advanced the English pronunciation of Korean EFL students. Additionally, Fan and colleagues (2019) reported improvements in the spoken English abilities of Chinese EFL learners through the use of AI. Collectively, these findings point to AI-powered speech recognition as a promising tool for enhancing the pronunciation of language learners.

Critical analysis of the literature reviewed on AI-powered speech recognition technology in language learning reveals several key areas for further study. There is a lack of discussion about AI's potential drawbacks, such as reduced human engagement and accessibility issues. The analysis suggests studying how the technology affects different learner demographics. It emphasizes the need for detailed pedagogical strategies to integrate technology into language learning. To determine the credibility and long-term effects of AI-facilitated learning, the referenced studies' research methodologies must be carefully examined. Ultimately, it emphasizes the need for resources and help in integrating these technologies into the curriculum and the challenges of teaching educators to use them.

Recent Developments in AI-SRT for EFL Learners (2023-2024)

Recent years have witnessed significant strides in the field of artificial intelligence (AI), particularly in its application to language learning and speech recognition technologies. Thes following literature reviews examined studies from 2023 to 2024 that exploring the use of AI-powered tools to improve English pronunciation and speaking skills.

With a cohort of English language learners, Mohammadkarimi (2024) tested Listnr and Murf AI pronunciation aids. A mixed-method study found that students who used these tools over traditional teaching methods improved their pronunciation. Positive attitudes toward AI-driven aids included increased engagement and confidence. The researchers also found difficulties in feedback interpretation and capturing subtle pronunciation nuances, suggesting AI technology needs improvement (Mohammadkarimi, 2024). Du and Daniel (2024) conducted a systematic review of AI chatbots' impact on English speaking skills. Their analysis of 24 studies showed that AI chatbots are still in their infancy, requiring further research. The results suggested AI chatbots can boost learning, reduce speaking anxiety, and improve pronunciation. Because AI chatbots can improve learning, English teachers, chatbot designers, and researchers should investigate them (Du & Daniel, 2024). Persulessy and colleagues (2024) examined civil engineering students' perceptions of learning engineering English vocabulary with ELSA

(English Language Speech Assistant). Students loved learning with AI, according to the descriptive research. The app's feedback mechanism motivated users, indicating a bright future for AI-assisted language learning in specialized fields (Persulessy et al., 2024).

The studies reviewed provide compelling insights into the integration of AI in language learning, particularly in enhancing English pronunciation and speaking skills. Mohammadkarimi (2024) presented a robust case for AI pronunciation tools, with quantitative data to back up qualitative perceptions. However, the study's limitations in feedback accuracy pointed to the need for more sophisticated AI algorithms capable of mimicking human-like feedback. Du and Daniel's (2024) systematic review broadened the scope of the field by analyzing the potential of AI chatbots across various studies. This meta-analytical approach was helpful in understanding broader trends and collective outcomes. Nonetheless, the review underscored the infancy of research in this domain, suggesting a vast potential for future studies to bridge the gap in knowledge and application. The focus on specialized vocabulary learning in Persulessy and colleagues' (2024) study added a unique dimension to the understanding of AI's role in language education. By examining a niche area of engineering English, this research offered a glimpse into the adaptability of AI tools across different disciplines. However, the study's sample size and single application focus might limit the generalizability of its findings.

Collectively, these studies highlight the transformative potential of AI in language learning. They also underscored the nascent state of this research field, advocating for continued development and exploration of AI capabilities. Future research should aim to address the challenges identified, such as feedback interpretation, and extend the application of AI tools to a wider range of learning environments and disciplines.

Research Methodology

To comprehensively evaluate the effectiveness of the Speechling program—an AI-powered speech recognition technology—in enhancing English pronunciation and speaking skills, this study employed a mixed-methods approach. Quantitative data was collected using a pre-test/post-test design to quantitatively measure the program's impact. Concurrently, qualitative insights were gleaned from participants' responses to a survey questionnaire, tailored to capture their perceptions of the program.

Participants and Pilot Testing

Participants for the research were drawn from a local university's sophomore EFL students during the Academic Year 2022. A convenient sample of 25 students, aged between 18 and 22, was selected from the English Listening & Speaking 3 Course. They were identified as having an intermediate level of English proficiency. Before commencing the full study, a pilot test was conducted with a smaller, separate group of students from a similar demographic, to refine the research instruments. The participants for the pilot test were chosen based on their availability and similarity to the target study group. Following the pilot, adjustments were made to the test

items and survey questions based on the initial feedback to enhance clarity, relevance, and engagement.

Research Instruments: Pre-test, Post-test, and Survey Questionnaire

The pre-test and post-test consisted of 30 items designed to evaluate pronunciation (20 items) and speaking skills (10 items). The Speechling program's content informed the test items, guaranteeing their pertinence. Each component of the test had a 30-minute completion time, with consistency in difficulty maintained across pre-test and post-test items.

The survey questionnaire, comprising 12 questions with a 5-point Likert scale and an open-ended question, solicited students' subjective experiences with the Speechling program. The selection of questions was informed by the pilot test feedback to ensure they effectively captured a comprehensive range of student experiences.

Data Collection Procedures

Data collection commenced with a thorough review of the research instruments. Participants information and privacy were safeguarded through strategic planning and the establishment of clear protocols. This included the distribution of consent forms, which were securely stored along with participants' data. Only the researcher had access to the collected data to maintain confidentiality.

During the first class, participants were introduced to the Speechling program and trained on its usage. The pre-test was administered under standardized conditions, followed by the intervention period with the Speechling program. Upon completion of the intervention, the post-test and survey questionnaire were administered with an emphasis on honest and thoughtful completion.

Data Transcription, Coding, and Analysis

Information gathered from the assessments and questionnaires was methodically transcribed and encoded. This entailed a thorough routine of inputting data, succeeded by statistical evaluation with the aid of suitable software tools. Descriptive statistics were utilized to encapsulate the data, and inferential statistics, including averages and standard deviations, evaluated the program's effect. The qualitative feedback underwent scrutiny to extract themes and discern patterns, and these insights were then examined in the context of the study's primary objectives.

Ethical Considerations

To protect participants, ethical protocols were strictly adhered to throughout the study. This included obtaining informed consent, ensuring anonymity in data handling, and securing data

access to authorized researcher only. These measures were paramount to ensuring the ethical integrity of the research.

In conclusion, the methodology was designed to be comprehensive and rigorous, incorporating pilot testing feedback for instrument refinement, adhering to ethical standards for participant protection, and employing a combination of quantitative and qualitative analysis to provide a holistic evaluation of the AI-SRT program's efficacy.

Results

Pre-Test and Post-Test

The step of the analysis was to delineate the outcomes of the pre-test and post-test evaluations. These evaluations were designed to measure learners' pronunciation proficiency. The data encompassed the performance of 25 participants

Table 1 illustrates the enhancement of pronunciation skills among 25 participants following an educational intervention. The mean score increased from 6.40 to 13.20. The pre-intervention score ranged from 10% to 70%, reflecting a range of abilities, while post-intervention scores ranged from 35% to 95%, marking substantial improvement. Despite a slight increase in the standard deviation from 3.14 to 3.30, the data suggests a more uniform improvement across the group, with median scores also rising from 35% to 75%. A paired t-test confirmed the statistical significance of these improvements, with a t-value of 7.46 and a p-value of less than .05. Hence, the progress in pronunciation abilities can be confidently attributed to the educational intervention.

Table 1
Pronunciation Abilities Pre-Test and Post-Test Results

Test	*n*	Mean	SD	Minimum	Maximum
Pre-Test	25	6.40	3.14	2.00	14.00
Post-Test	25	13.20	3.30	7.00	19.00

The data underscores an improvement in pronunciation among the 25 students from the pre-test to the post-test. This finding implied that educators and language instructors can enhance students' pronunciation skills by offering more speaking opportunities, employing visual aids, and addressing pronunciation errors promptly. A paired *t*-test was conducted to ascertain the significance of this improvement.

Table 2 displays a significant increase in the speaking skills of the 25 participants after an educational intervention. The means scores rose from 3.28 to 7.12 out of 20. The standard deviation remained relatively stable, shifting slightly from 1.55 on the pre-test to 1.47 on the post-test, indicating a consistent spread of scores around the mean. The minimum scores

increased from 3 to a higher minimum of 12, while the median scores also improved from 3 to 8, showcasing the participants' improved performance.

Table 2
Speaking Abilities Pre-Test and Post-Test Results

Test	*n*	Mean	SD	Minimum	Maximum
Pre-Test	25	3.28	1.55	3.00	7.00
Post-Test	25	7.12	1.47	8.00	12.00

A paired t-test confirmed the statistical significance of these improvements, with a t-value of 13.11 and $p<.05$. Hence, the progress in speaking abilities can be confidently attributed to the educational intervention.

General Implications and Limitations

The findings from this study offer valuable insights for language instructors aiming to bolster speaking proficiency. The successful intervention led to a demonstrable improvement in students' speaking skills, as shown by both descriptive and inferential statistical analyses.

However, it's important to recognize the limitations of this research. Conducted with a relatively small cohort, the study focused narrowly on a single aspect of language learning. Future research should consider larger sample sizes and encompass additional language skills to build upon these findings.

Despite these limitations, the investigation highlights the potential efficacy of targeted language-improvement interventions, with a particular emphasis on the role of descriptive and inferential statistics in gauging their success.

Table 3 shows 25 students' improved speaking abilities, with normalized scores rising from 0.33 to 0.70. The intervention improved participants' performance more uniformly, lowering SD from 0.18 pre-test to 0.16 post-test. Adding AI-powered speech recognition to the curriculum improved academic performance. This technology, along with personalized instruction and immediate feedback, improves pronunciation and oral communication. The study confirms previous research on technology-assisted language learning. However, the small sample size and participant homogeneity may limit the results' applicability.

Table 3
Speaking Abilities Pre-Test and Post-Test Results

Test	*n*	Mean	SD
Pre-Test	25	0.33	0.18
Post-Test	25	0.70	0.16

Finally, using AI in language learning improves pronunciation and speaking. Language teachers can provide more engaging, individualized learning experiences that improve language acquisition by incorporating such innovations.

Results from the Survey Questionnaire

The survey results revealed a unanimous agreement that the program exercises significantly enhanced the participants' pronunciation, speaking abilities, and vocabulary acquisition. Specifically, 22 (88%) students strongly believed in the program's effectiveness in improving pronunciation, while the majority confirmed its benefits for speaking skills. This aligns with the findings reported by Shao and colleagues (2018). Shao and colleagues (2018) and Lee and Jang (2018), reported similar findings regarding speech recognition systems. All participants acknowledged the program's role in learning new words, which echoes Kuo and colleagues' (2017) findings on vocabulary development through speech recognition technology.

Furthermore, the program was found to be engaging and attention-grabbing. Twenty-three (92%) of participants reported sustained focus during exercises. Motivation to practice English was reported by 15 (60%) participants, supporting Liu and Yang (2019)'s discovery of speech recognition's motivational impact. An overwhelming majority concurred that the program was instrumental in refining their pronunciation and bolstering their confidence in English speaking, a sentiment found by Wang and Hisao (2018).

Every participant strongly agreed on the program's efficacy in correcting pronunciation errors, reinforcing Zhang and colleagues' (2018) study outcomes. The program also proved helpful in amending speaking errors, as agreed by 18 (72%) participants, mirroring Lee and Jang (2018)'s findings. The exercises' variety and the flexibility of practicing English anywhere were highly praised, aligning with mobile and online language learning benefits highlighted by Kukulska-Hulme and Shield (2008). Additionally, the program's ease of use and enjoyment factor were emphasized, which are crucial for user satisfaction and effective learning as noted by Sanz-Torrent and colleagues (2018) and Jang and Wu (2018).

In summary, the Speechling program, facilitated by AI-powered speech recognition technology (AI-SRT), was unanimously recognized for its positive impact on language skills, with a strong endorsement from the participants for its pronunciation, speaking, and vocabulary exercises, motivational appeal, error correction capabilities, and enjoyable, accessible learning experience.

Quantitative Results

Participants were asked what they liked best about the Speechling program. The program received positive feedback from students for its effective approach to language learning. Key aspects that students valued the most included the program's flexibility, allowing for practice at any time and place, and its user-friendly interface, which enhanced the learning experience. The inclusion of a rich vocabulary and the ability to receive immediate, precise feedback on

pronunciation were highlighted as significant benefits, contributing to improved confidence and speaking abilities. The program's structure, which facilitates tracking progress, alongside a variety of accents for listening practice, was appreciated for helping students become accustomed to different English speakers and overcome language apprehension.

Moreover, the program's adaptive difficulty levels enabled personalized progression, and the engaging speaking practice questions kept learning enjoyable. Its high-precision speech recognition technology, which closely resembles human speech, added authenticity to the learning process. The program also offered a vast collection of audio recordings and realistic speaking scenarios, making it both comprehensive and practical. Affordability and easy access were mentioned as additional advantages for students who are mindful of their budgets.

In summary, the study highlighted the Speechling program's effectiveness in enhancing English pronunciation and speaking skills, supported by current research on the positive impacts of AI-assisted language programs. The program's varied features—flexible practice settings, diverse vocabulary, adaptive levels, and authentic speech recognition—contributed to a dynamic and effective learning journey. The study's qualitative findings suggests that technology-assisted pronunciation and speaking training should be an integral part of language-learning curricula, offering a tailored and enriched experience for learners. Further investigation is encouraged to explore the long-term benefits, best instructional practices, and integration strategies for such programs in diverse learning environments.

Discussion and Conclusion

The application of AI-powered speech recognition technology in enhancing English pronunciation and speaking skills among EFL students has promising outcomes. This study, underpinned by the interactionist approach to Second Language Acquisition, highlighted the significant role of meaningful interactions and targeted practice facilitated by AI-SRT. The instant feedback and the opportunity for repetitive, focused oral practice have proven to be effective in improving pronunciation and oral fluency, resonated with findings by Liu and Yang (2019) and Chen and Wang (2017). The technology's role as a virtual language instructor offering personalized feedback suggested its potential to substantially improve sound production and speaking skills.

EFL students' English pronunciation and speaking skills have improved with AI-SRT. This study, based on the interactionist approach to Second Language Acquisition emphasized AI-SRT-facilitated meaningful interactions and targeted practice. Liu and Yang (2019) and Chen and Wang (2017) found that instant feedback and repetitive, focused oral practice improved pronunciation and fluency. The technology's role as a virtual language instructor providing personalized feedback suggested it could greatly improve sound production and speaking.

Learner variables like motivation, attitudes toward technology, and prior language proficiency affected engagement and perceptions of the technology's impact. This is consistent with the work of Kim and Lee (2019) and Sung (2018), that reported learner motivation and positive

attitudes toward technology improve language learning outcomes. Wang and Sun (2020) and Gao and colleagues (2019) agreed that AI-SRT's authentic conversational practice and immediate feedback support interactionist SLA theory and the importance of meaningful practice. Wu and colleagues (2018) and Zhang and team (2022) recommended seamless and purposeful AI-SRT integration into language learning environments that aligns with instructional design and pedagogical goals. The study recommended including speech recognition technology in the curriculum to aid language development, provided that teachers and students receive proper training and support, as noted by Lee and Jang (2018) and Zhang and colleagues (2022).

The current study supports AI-SRT's efficacy, but practical considerations for its integration into language curricula must be critically examined. To keep up with learners' changing needs and language acquisition, technology must be assessed regularly. Technology's potential as a crutch rather than a tool for learning raises the question of how to balance it with other teaching methods to promote independent language development. The accessibility and inclusivity of AI-SRT must also be assessed. The technology allows anytime, anywhere practice, but socioeconomic factors and student digital literacy may limit access. Additionally, AI-SRT's ability to accommodate different learning preferences and disabilities has not been extensively explored. Furthermore, the study's findings suggest that while immediate feedback is beneficial, it is the quality and specificity of the feedback that may determine the extent of improvement in pronunciation and speaking skills. Therefore, ongoing refinement of speech recognition algorithms to provide nuanced feedback is crucial for the sustained effectiveness of AI-SRT.

Finally, AI-SRT may continue improving language learning, but more nuanced, longitudinal studies are needed to determine its long-term effects and optimal integration strategies for diverse learning contexts. This includes studying how it affects students of different proficiency levels, learning styles, and cultures. In conclusion, the Speechling program and other AI-SRT tools offer innovative language learning methods, but their practical application requires careful consideration of pedagogical, technological, and learner-related factors to ensure that they complement traditional language instruction and serve a wide range of learners.

Conclusion

An AI-powered Speech Recognition Technology was tested to improve EFL students' English pronunciation and speaking. The study yielded important findings.

Drawing on the interactionist approach to second language acquisition, AI-powered speech recognition technology aided meaningful interactions and targeted practice. Students could receive instant feedback and practice pronunciation and oral fluency with the technology.
Technology integration in language learning was also shown to be important. Students were supported and engaged by speech recognition technology powered by artificial intelligence. The technology provided personalized feedback and instruction as a virtual language instructor, improving students' sound production and speaking skills.

The study also considered how learner variables affect intervention efficacy. Learners' engagement with AI-powered speech recognition technology and perceptions of its impact on language learning were influenced by motivation, attitudes toward technology, and prior language proficiency. The results of this study contribute to the existing literature on AI-assisted language learning and shed light on the potential benefits of AI-powered speech recognition technology for enhancing pronunciation and speaking abilities. When designing effective language learning interventions, the study highlights the importance of considering the dynamic relationship between language acquisition theories, technology integration, and learner factors.

This study supports the use of speech recognition technology powered by artificial intelligence as a valuable tool for improving EFL students' English pronunciation and speaking abilities. The findings indicate that integrating technology into language learning environments can enhance the learning experience and result in more effective language acquisition. However, additional research is needed to investigate the long-term effects of these interventions and to address potential challenges associated with the use of technology in language education.

Limitation of the Study

This research study provided valuable insights, but its limitations should be considered in future studies. First, the study only included EFL students and may not apply to learners of other languages. AI-powered speech recognition may not work for all EFL learners due to age, language proficiency, and culture. Second, the small sample limited generalizability. A larger, more diverse sample could explain how AI-powered speech recognition affects pronunciation and speaking. Another drawback is self-reporting and subjective evaluations. Pre-tests, post-tests, and surveys are useful, but more objective measures are needed to confirm the findings. Expert evaluations and objective pronunciation tests would strengthen the study's findings.

The study also did not examine the long-term effects of AI-driven speech recognition on language learning. The technology's durability can be better understood through longitudinal student studies. The study did not address technological barriers to implementing AI-powered speech recognition in language learning environments. To ensure technology applicability and efficacy, future research should focus on system precision, user interface design, and accessibility.

This study illuminates how artificial intelligence-powered speech recognition technology may improve English pronunciation and speaking. To better understand how technology affects language learning, future research should address these limitations and expand on the findings.

Suggestions for Further Studies

This research study has a number of recommendations for future research that can be made in order to broaden and deepen our understanding of this field. These recommendations are based on the findings and limitations of the research study.

The study of AI-powered speech recognition technology in language learning includes multiple narrative threads with different perspectives on its effectiveness and use. Foundational longitudinal studies track student progress over time. These studies examine the long-term effects of AI-powered speech recognition technology on pronunciation, speaking, and language proficiency. By studying this perspective, researchers can better understand how this technology affects language learning over time and describe its benefits.

Comparative research seeks understanding. The user compares AI-powered speech recognition technology to other language learning methods to determine its benefits. Teachers learn how to use this technology most effectively by analyzing different teaching methods and intervention strategies. In complex studies, learner factor shifts are important. Researchers examine how age, language proficiency, motivation, and AI-powered speech recognition technology affect learner performance. This study illuminates the complex interaction between individual variations and technological intervention, resulting in customized and flexible learning environments for a variety of learners.

The study emphasizes technological optimization. AI-powered speech recognition technology is researched to improve its design and functionality. By assessing system clarity, user interface layout, and user input, they strategically plan to improve the technology's usability and effectiveness to meet learners' needs. Language acquisition is fascinating and varied when studied across cultures. Researchers test AI-driven speech recognition technology in different cultures and languages. This study examines how subtle cultural influences affect technology use and effectiveness by comparing the experiences and results of EFL students from diverse cultural backgrounds. This research helps us understand multicultural technology use.

These recommendations can help researchers better understand how AI-powered Speech Recognition Technology can improve EFL learners' English pronunciation and speaking skills.

References

Bohn, O.-S., & Munro, M. J. (2020). Second language speech learning: Theory, findings, and problems. In T. S. Cardoso & J. N. Y. Levis (Eds.), *The Routledge Handbook of Second Language Acquisition and Phonology* (pp. 69–85). Routledge.

Chen, C.-M., & Wang, H.-W. (2017). A review of using speech technology in English pronunciation training. *Journal of Educational Technology & Society*, *20(2)*, 228–238.

Chen, G., & Duan, J. (2020). Artificial intelligence in language learning: A review of current applications and future potential. *Computer Assisted Language Learning*, *33(3)*, 257–274.

Du, J., & Daniel, B. K. (2024). Transforming language education: A systematic review of AI-powered chatbots for English as a foreign language speaking practice. *Computers and Education: Artificial Intelligence, 6*, 100230. https://doi.org/10.1016/j.caeai.2024.100230

Fan, Y., Huang, X., & Tan, S. (2019). The effectiveness of artificial intelligence technology in improving Chinese EFL learners' oral English proficiency. *Computer Assisted Language Learning, 32*(5–6), 495–514.

Gao, Y., Yang, J., & Zhang, X. (2019). The role of learner engagement in computer-assisted pronunciation training: A study with EFL learners in China. *Computer Assisted Language Learning, 32*(5-6), 507–529.

García-Sánchez, S., Soler-Urzúa, M., & Nussbaum, M. (2020). Effectiveness of an AI-assisted program to enhance English pronunciation in EFL university students. *Computer Assisted Language Learning, 33*(5–6), 568–590.

Jang, H., & Wu, Y. (2018). The impact of mobile game-based English learning on EFL students' motivation and English proficiency. *Journal of Educational Technology & Society, 21*(1), 1–13.

Jia, J., Wang, H., Yang, D., & Zhang, X. (2019). How effective is a computer-assisted pronunciation training (CAPT) program? A case study in China. *Computer Assisted Language Learning, 32*(5–6), 560–578.

Jia, R., & Zhang, C. (2018). The effectiveness of computer-assisted pronunciation training for speakers of different languages. *Educational Technology & Society, 21*(3), 261–274.

Kang, O. (2016). The importance of pronunciation in English communication. *International Journal of Language and Linguistics, 3*(1), 45–50.

Kim, J. (2019). The effects of artificial intelligence-based personalized pronunciation instruction on the English pronunciation skills of Korean EFL learners. *English Language Teaching, 12*(6), 32–51.

Kim, S., & Lee, J. (2019). The role of learner motivation and attitude in an intelligent computer-assisted language learning environment. *Computer Assisted Language Learning, 32*(5–6), 457–476.

Krashen, S. D. (1981). *Second language acquisition and second language learning*. Pergamon Press.

Kukulska-Hulme, A., & Shield, L. (2008). An overview of mobile assisted language learning: From content delivery to supported collaboration and interaction. *ReCALL, 20*(3), 271–289. https://doi.org/10.1017/S0958344008000335

Kuo, C. H., Yang, Y. T. C., Chen, I. J., & Wang, T. I. (2017). Effects of using speech recognition-assisted multimedia pronunciation learning system on English pronunciation and vocabulary learning. *Journal of Educational Technology & Society, 20*(1), 243–256.

Lee, C., & Jang, J. (2018). Effect of mobile pronunciation technology on English pronunciation practice. *Journal of Educational Technology & Society, 21*(2), 187–198.

Li, Y., & Li, C. (2021). Using artificial intelligence to support language learning: A systematic review. *Journal of Educational Computing Research, 59*(5), 1295–1326.

Liao, X., & Xue, J. (2019). Computer-assisted pronunciation training (CAPT) on improving vowel production of Chinese EFL learners. *Computer Assisted Language Learning, 32*(7), 607–629.

Liao, Y. K., & Xue, S. (2019). Investigating the effects of computer-assisted pronunciation training (CAPT) on English vowel production of Chinese EFL learners. *Computer Assisted Language Learning, 32*(5–6), 579–604.

Liu, W. C., & Yang, C. F. (2019). Mobile-assisted speaking practice for EFL college students. *Journal of Educational Technology & Society, 22*(3), 203–217.

Major, R. C. (2016). *Teaching pronunciation: The reference complement*. Routledge.

Mohammadkarimi, E. (2024). Exploring the use of artificial intelligence in promoting English language pronunciation skills. *LLT Journal: A Journal on Language and Language Learning, 27*(1), 98–115. Sanata Dharma University. https://doi.org/10.24071/llt.v27i1.8151

Morris, R. L. (2020). AI meets CAPT: Artificial intelligence-supported computer-assisted pronunciation training. *Computer Assisted Language Learning, 33*(3–4), 349–377.

Munro, M. J., & Derwing, T. M. (2016). Pronunciation teaching and learning: Effects of explicit phonetic instruction in the L2 classroom. *Canadian Modern Language Review, 72*(2), 166–189.

Persulessy, S. I., Nikijuluw, R. P. J. V., & Jakob, J. C. (2024). Utilizing artificial intelligence in language learning: What about engineering students' perception? *Journal of English Education Program, 5*(1), 48–58. https://doi.org/10.26418/jeep.v5i1.71159

Saito, K., & Lyster, R. (2019). Effects of form-focused instruction and corrective feedback on L2 pronunciation development of /ɹ/ by Japanese learners of English. *Applied Linguistics, 40*(2), 244–268.

Sanz-Torrent, M., Moreno-Sandoval, A., & Blanco-Suarez, C. (2018). Design and validation of an innovative mobile application to promote language learning. *Educational Technology Research and Development, 66*(6), 1395–1411.

Shao, L., Gao, Y., Wang, L., & Li, Y. (2018). Effects of an online speech recognition system on learners' English speaking performance. *Educational Technology Research and Development, 66*(2), 427–445.

Sung, Y. T. (2018). Using a mobile app-based video reflection activity to enhance student motivation and achievement in speaking proficiency. *Computer Assisted Language Learning, 31*(5-6), 490–510.

Thomson, R. I. (2018). *Teaching and learning English pronunciation: Research and practice*. Routledge.

Trofimovich, P., & Isaacs, W. (2019). Second language pronunciation. In J. W. Schwieter & A. Benati (Eds.), *The Cambridge Handbook of Second Language Acquisition* (pp. 349–369). Cambridge University Press.

Vygotsky, L. S. (1934). *Thought and Language* (E. Hanfmann & G. Vakar, Trans.). MIT Press.

Wang, J., & Sun, Y. C. (2020). Effects of focused instruction and interactional feedback on the improvement of L2 Chinese learners' Mandarin tones. *Computer Assisted Language Learning, 33*(5-6), 466–490.

Wang, S., & Hisao, C. (2018). Effects of the use of an automatic speech recognition system on Taiwanese EFL learners' oral proficiency. *Computer Assisted Language Learning, 31*(1–2), 39–59.

Wu, W. H., Wu, Y. C. J., Chen, C. Y., Kao, H. Y., Lin, C. H., & Huang, S. H. (2018). Review of trends from mobile learning studies: A meta-analysis. *Computers & Education, 123*, 119–135.

Yalcin, S., & Korkmazgil, S. (2021). The effectiveness of an AI-powered mobile application on the English pronunciation skills of EFL learners. *International Journal of Emerging Technologies in Learning (iJET), 16*(12), 135–148.

Zhang, H., Song, Y., & Lu, X. (2018). Investigating the effect of using a mobile-assisted pronunciation application on learners' pronunciation accuracy and fluency. *Language Learning & Technology, 22*(3), 111–129.

Zhang, Y., & Wei, L. (2019). The relationship between speaking ability and speaking anxiety in second language acquisition. *The Asia-Pacific Education Researcher, 28*(3–4), 181–192.

Zhang, Z., Li, Y., Wang, Y., & Cheng, G. (2022). The effectiveness of artificial intelligence technology on foreign language learning: A meta-analysis. *Educational Technology Research and Development, 70*(2), 713–741.

Zhao, Y., Chen, Y., & Ma, F. (2021). Effects of AI-assisted technology on second language pronunciation accuracy, fluency, and anxiety: A meta-analysis. *Computer Assisted Language Learning, 34*(7), 756–779.

Zou, D., Deng, Z., Li, C., & Chen, Q. (2021). Improving oral English skills with artificial intelligence: The effectiveness of AI-powered speech recognition technology. *Educational Technology Research and Development, 69*(4), 1919–1944.

Corresponding author: Nutprapha K. Dennis
Email: nootprapa@gmail.com

Academic and Social Adjustment to Post-Pandemic Hybrid Learning: A Phenomenological Study of Filipino First-Year Engineering Students' Experiences

Maria Cristina M. Firmante
De La Salle University, Philippines

Abstract

The effects of the COVID-19 pandemic caused immense changes, particularly in education. There has been a shift from mostly face-to-face to increased remote learning, and students have tried to adapt to this change. Hybrid classes are now implemented as students adjust to the new normal of the post-pandemic era. While the transition for some can be smooth and challenging for others, literature shows that adjustment comes with a wide range of experiences. Thus, this action research aims to understand better first-year engineering students' academic and social adjustment in a hybrid setting. A phenomenological approach was employed, involving thirty (30) first-year engineering students who participated in online focus group discussions. Transcripts from the focus group discussions were coded, categorized, and thematically analyzed. Observations during the interview were analyzed, and students' written essays were examined. Findings of the academic adjustments toward hybrid learning indicated that the online modality is integral to student learning, making it flexible and inclusive. Combining online and in-person classes on the same day can add to the challenge of transitioning. Moreover, the social adjustment of first-year students focused on the lack of social interaction and social support that can significantly impact their success. Implications for program development were discussed.

Keywords: academic adjustment, engineering, first-year students, hybrid learning, lived experiences, social adjustment

Scholars started investigating the idea of college student adjustment in the 1960s (Jones, 1966), while researchers established a college student adjustment model focusing on academic, social, personal-emotional adjustment, and institutional attachment (Baker & Siryk, 1989). Research conducted globally suggests that adjustment to the multiple transitions from higher education experiences plays a significant role in students' success (Jindal-Snape & Rienties, 2016). For many students, starting their first year of college includes significant changes in their levels of independence and responsibility. While going to university is an exciting experience, some students have expectations before leaving home. Some are eager to experience more freedom and adventure, while others may discover that the experience falls short of their expectations (Al-Qaisy, 2010). They must learn to work in a new environment, live independently, and work with new people (Van Viet, 2021) and experience stressors related to their academic and social adjustments (McCabe, 2016; Terenzini et al., 1994; Van Viet, 2021).

However, when the COVID-19 pandemic appeared in early 2020, it caused an immense change in everyone's lives. The unprecedented effects of the pandemic challenged universities and students. In particular, schools adapted and shifted to new education methods surprisingly well (Bubb & Jones, 2020). The unexpected turn of events led by the outbreak of the COVID-19 pandemic forced educators, regardless of their stance on online education, familiarity, and level of preparedness, to transition into a completely online system of education with hardly any time to make this transition (Dhawan, 2020). The abrupt switch to fully online learning was particularly stressful for many professors and students who prefer in-person instruction. With or without a global pandemic, there is a significant jump in the academic workload first-year students experience going from high school to college. At the same time, socially, first-year students may have left some of their previous social networks and must establish a new support system, which was made more difficult due to restrictions during the COVID-19 pandemic (Ang et al., 2022). Hence, online education is frequently labeled as less desirable, offering a lower-quality education than in-person, face-to-face instruction (Hodges et al., 2020).

The abrupt shift to online learning presents challenges for engineering students, as their education relies heavily on hands-on experiences in laboratory classes and direct interaction with instructors and peers (Balta-Salvador et al., 2021). A significant portion of engineering curricula is centered around applying theoretical knowledge in practical settings, particularly in laboratory classes (Jacques et al., 2020). Despite these preferences and constraints, online education has gradually become integral to higher education in engineering subfields such as electrical and computer engineering, computer science, and information technology over the past decade (Martinez et al., 2005). Notably, conducting laboratory classes presents a specific challenge (Grodotzki et al., 2021). As highlighted by Park et al. (2020), the transition has been difficult, especially in facilitating lab courses, which are essential for undergraduate engineering programs and are a requirement for program accreditation by the Accreditation Board for Engineering and Technology (ABET).

Within this context, the researcher of the present study, who is also a practicing school counselor, hopes to provide information on the lived experiences of first-year engineering students as they transition from face-to-face to hybrid classes. The study also hopes to

contribute to the existing literature on first-year engineering students' academic and social adjustment experiences, particularly in a new learning modality. At present, there is no existing program in the researcher's counseling office related to the transition to hybrid classes for first-year engineering students. The result of the present study will provide the researcher with essential information in developing a program specific and unique to first-year engineering students' needs.

Research Problem

The present study explored the academic and social adjustment experiences of first-year engineering students as a basis for program development. It was the hope of the researcher, who is also a practicing school counselor, to come up with a program specific and unique to the needs of first-year engineering students.

Specifically, the study sought to address the question: *What are the lived experiences of first-year engineering students toward the hybrid learning in terms of*: *1) academic adjustments and 1.2 social adjustments?*

Literature Review

Academic Adjustment

Academic adjustment is considered an individual ability to manage various academic challenges. Baker and Siryk (1989) defined academic adjustment as the ability of students to adequately cope with the educational demands of the college experience. Students who succeed in academic adjustment will show success in academic lifestyle, academic achievement, and academic motivation (Anderson et al., 2016). Academic adjustment is how students overcome various academic challenges to attain better grades in the university (Clinciu & Cazan, 2013). However, the adverse effects of academic non-adjustment of students may result in early dropout, difficulty handling stress, less drive to study, and low academic performance (Reddy et al., 2018). Failure to adjust academically to first-year students could also lead to stress, anxiety, moodiness, depression, and even poor mental health (Clinciu, 2012).

Several factors influence students' academic adjustments. A study by Montgomery and colleagues (2019) found that intrapersonal factors significantly influence associations with academic adjustment even when controlling for academic motivation. Students' academic motivation mattered, as did their orientation. External factors appear unaffected by academic adjustment, but intrinsic motivation was linked with higher adjustment. At the same time, perfectionism was shown to have a superlative and discriminative association with academic adjustment, depending on whether it was an adaptive or maladaptive form of perfectionism. In the Philippines, Alipio (2020) examined whether the senior high school (SHS) students' specific area of specialization mattered for Filipino first-year college students' academic adjustment and performance. Results of the study found that a significant difference existed among the students in different SHS strands, suggesting that the academic adjustment and

performance of the students varied based on the SHS strand taken. Moreover, the researcher recommended that guidance counselors in higher-education institutions create guidance programs specifically designed for first-year college students to facilitate their transition and adjustment to college.

Social Adjustment

Transitioning to university entails integration into a new social environment. Students get to know and spend time with fellow students and participate in social activities organized by student organizations (Stephens et al., 2015). Like academic adjustment, social adjustment is as vital as any other dimension in students' transitions (Enochs & Rolland, 2006; Gerdes & Mallinckrodt, 1994). Social adjustment refers to how students maintain a sense of belonging in their respective colleges and connection with other members by fostering positive interpersonal relationships and participating in diverse activities in school (Ko & Lee, 2013).

The National Academies of Sciences, Engineering, and Medicine (2017) posited that students' feelings of belonging is a possible lever to support success, engagement, and well-being in college. In addition, Sahin and colleagues (2016) found that students who cannot establish positive relationships with friends, teachers, and school administrators do not like the school, and have a higher tendency to be absent from school and to drop out. According to Shim and Ryan (2019), when a student's goal is social development, college adjustment and social competence were higher.

Hybrid and Blended Learning Approach

Dorn and colleagues (2020) posited that the academic year 2020–2021 was one of the most challenging times for faculty, students, and administrators. K-12 schools, universities, and other higher education institutions rapidly transitioned to online learning to continue education during the COVID-19 pandemic (Singh et al., 2021). Some studies have reported that while transitioning to online teaching, teachers faced issues related to their classroom pedagogical practices; some even doubted their teaching abilities and questioned the learning outcomes of students (Ulla & Perales, 2021a; Maatuk et al., 2022), while students encountered challenges like lack of access to academic resources and distractions in the home learning environment (Clabaugh et al., 2021). In addition, students may have had experienced negative emotions due to the hurried switch to an unfamiliar learning situation (Park et al., 2020).

Despite the challenges that arose in education due to the COVID-19 pandemic, the transition to online learning caught the interest of some education scholars, practitioners, and researchers interested in innovating within the traditional face-to-face learning practice (Ulla & Perales, 2022). Online learning started gaining popularity in the 1990s when students could complete their coursework without coming to campus and being physically present (Nortvig et al., 2018). Previous evidence suggested hybrid or blended learning offers creative options to academic leaders and faculty, making information available to students outside the classroom. Hybrid or

blended learning can help in optimizing and maximizing students' productivity during in-person sessions (Powell et al., 2015).

In engineering education, online education has become a viable component of higher education in engineering subfields like electrical and computer engineering, computer science, and information technology, particularly at the master's or postgraduate level (Martinez et al., 2005). However, online, hybrid or blended learning programs can be successful or unsuccessful if not appropriately planned and executed in terms of their structure, objectives, learning outcomes, taxonomy, and specific to students' needs (McGee & Reis, 2012). One study by Alfiras and colleagues (2021) explored students' perceptions of hybrid classes at the College of Interior Design Engineering, Gulf University. The study results identified that hybrid classes are practical, and to make them even better, specified parameters such as teachers' efficiency, the importance of advanced learning management system and communication over the internet should be regularized and enhanced. The study also reiterated that the emotional connection a teacher establishes, and the constructive feedback that a teacher provides, make studying more positive and welcoming for students.

Conceptual Framework

The current study's conceptual framework provides a proposition for understanding the lived experiences of first-year engineering students as they transition from face-to-face to hybrid classes. This framework is guided by Tinto's (1975) attrition model, which explores various educational experiences, competencies, and skills of students. The model also considers students' values and family and community backgrounds before they enter higher education. As a result, academic and social adaptation are shown to influence students' integration into higher education, increase school cohesion, and lead to student perseverance and graduation. Tinto emphasized the importance of academic and social integration, arguing that it is essential for sustaining institutional and goal commitments and, consequently, college retention. He contends that in order to succeed in college, students must adequately integrate into both the academic and social facets of college life.

Figure 1

Academic and Social Adjustment Experiences of First-year Engineering Students

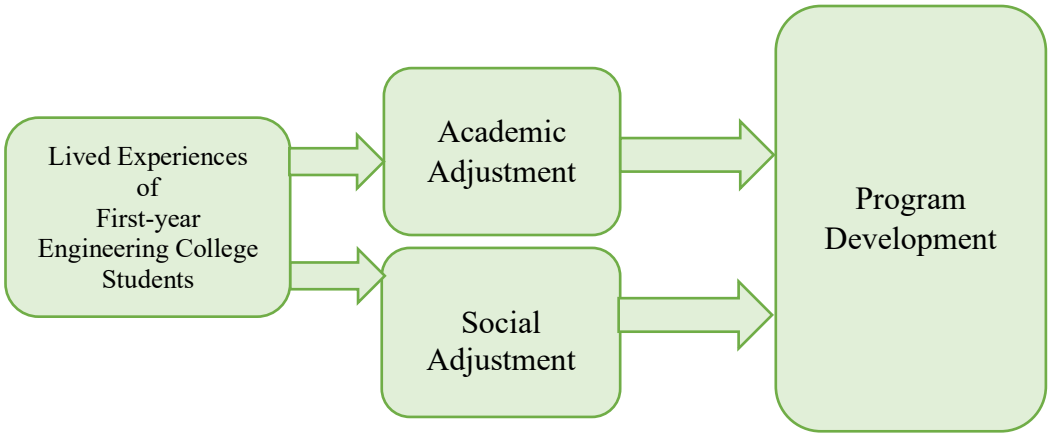


Figure 1 shows the conceptual framework of the present study. The framework was summed up based on previous literature. Guided by this framework, the lived experiences of first-year engineering students were explored in terms of their academic and social adjustments. Results will be the basis for program development.

Methodology

Research Design

The method used in the present study is action research employing a phenomenological qualitative approach. Mills (2000) posited that action research is any systematic investigation carried out by teacher researchers, principals, school counselors, or other individuals in a learning environment to know more about how specific schools operate, how teachers teach, and how well students learn. Employing a phenomenological qualitative approach to action research was selected for this study because the aims was to explore the *experiences* of first-year students in depth. In a qualitative approach, researchers aim to comprehend the participants' unique world by listening carefully and attempting to capture the significance they place on their lives and experiences (Ponterotto, 2005).

Research Participants

The present study's participants comprised thirty (30) first-year engineering students enrolled in hybrid classes. Since this paper utilized the action research design, the participants who experienced the action to be investigated (i.e., the transition to hybrid classes) were chosen and were composed of five (5) participants per academic program within the engineering department. Specifically, the participants were selected purposively as they were the ones who experienced the action under investigation. The programs included chemical engineering, civil engineering, electronics and computer engineering, industrial and systems engineering, manufacturing engineering and management, and mechanical engineering. Purposeful sampling seeks cases with as much in-depth information that can be investigated (Patton, 2002). It is also interesting to note that the participants were the first batch experiencing the full implementation of the hybrid class.

Table 1 shows the demographic profile of the participants. Their ages ranged between 17 years old and 22 years old. Minor participants were required to complete consent and assent forms before participating. Of the 30 participants, 16 (53.0%) were male, 11 (37.0%) were female, and 3 (10.0%) chose not to provide their gender.

Table 1
Demographic Profile of First-Year Engineering Students

Variable	Characteristics	*n*	%
Age	17-18 years old	18	60.0%
	19-20 years old	8	27.0%
	21-22 years old	4	13.0%
Gender	Male	16	53.0%
	Female	11	37.0%
	Prefer not to respond	3	10.0%
Major/Program	Civil Engineering	5	16.6%
	Chemical Engineering	5	16.6%
	Electronics and Computer Engineering	5	16.6%
	Industrial Engineering	5	16.6%
	Manufacturing Engineering	5	16.6%
	Mechanical Engineering	5	16.6%

Note. N=30

Research Instruments

Three research instruments were used in the present study: (1) the researcher-made focus group discussion protocol, (2) the researcher's observations during the interviews (field notes), and (3) students' essays about their academic and social adjustment.

Focus Group Discussion Protocol

Three school counselors handling college students validated the researcher-made focus group (FGD) protocol. Focus groups are group interviews that communicate with study participants to gather information. They enable interactive and in-depth exploration of respondents' experiences, and the group process can help clarify each view that might not emerge from a one-on-one interview that the present study's author believes best fits its purpose (Kitzinger, 1995). The focus group technique allows for spontaneous information exchange and the expression of participants' knowledge and ideas. Participants can think aloud in a focus group discussion and are free to say what they believe or think. Moreover, information obtained from focus group discussions can be deeper than from face-to-face interviews because of the social interaction among the participants (Thomas et al., 1995).

Researcher's Field Notes (Observations)

Field notes were an additional data source that included detailed information on observations before, during, and after the focus group interview. The researcher's field notes included the date, time, and details of the observation period. The researcher established rapport and trust

with the virtual research participants by delivering non-verbal cues and engaging them throughout the interview. Direct quotations from the participants that were significant or representative of common themes, including non-verbal cues, were written down to ensure accurate capture of what was said and how it was communicated. Additionally, the researcher's interpretations of and reflections on the observations and gathered data were also documented.

Students' Essay

The researcher initially reached out to a professor who teaches first-year engineering students to discuss the research they were conducting. The use of the essay in the study was thoroughly discussed with the professor. Upon the professor's confirmation of participation, informed consent was obtained from the students. They were provided with detailed information and the objectives of the research. The essay focused on students' academic and social adjustment in a hybrid setting. The students were asked to write a one to two-page essay about their experiences as first-year engineering students, focusing on their academic and social adjustment. This was part of their class requirements and was done in collaboration with the professor. The professor provided the criteria for the essay, which included focus and details, organization, choice of words, and sentence structure. All thirty (30) participants completed the essay.

Data Gathering Procedure

The researcher followed the three phases of action research: pre-implementation, implementation, and post-implementation. In the pre-implementation phase, the researcher obtained ethical approval from the research ethics office of the participating private university in Manila, Philippines. Upon the approval, an invitation to participate in the study was announced to the engineering student council. The researcher sought assistance from the student council to share and disseminate the invitation letter to participate in research intended for first-year engineering students per program through a focus group discussion. Along with this, the researcher also connected with the professors handling first-year engineering students for the essay part of data collection. The essay was part of the requirements of students in the class. The researcher of the present study prepared semi-structured questions during the focus group discussion that focused on the lived experiences of first-year engineering students' academic and social adjustment in the hybrid setting. Similar questions were also asked of the students who answered the essay. Students were also provided with informed consent.

During the implementation phase, students who opted to participate in the study received email instructions about the online focus group discussion and were informed that the meeting platform was Zoom. They were instructed to use their university-assigned email addresses to join the online discussion. Participants consented to allowing the researcher to use the gathered data for research and program development. Consent was obtained via Google Forms, which reiterated that no identifiable information would be shared if the collected data was to be used for research presentation or publication. The study conducted during the academic year 2023–2024.

Moreover, after acquiring the result of the focus group discussion, program development will follow for the post-implementation phase.

Data Analysis

Thematic analysis was performed on the focus group, observation, and student essays data. The analysis followed Braun and Clark's (2006) guidelines. First, the participants' audio-recorded interviews were transcribed verbatim. The researcher familiarized herself with the data by carefully listening to the recorded interviews, reading the transcripts, going through the whole data.. The second step was generating initial codes and categories by labeling data segments or the gathered answers. The researcher listed all the codes, combined similar codes into broader categories, and counted the number of respondents who responded the same. Third, the researcher searched for themes and then reviewed them as the fourth step. The fifth step was to define and name the themes accordingly, and the last step was generating the final report. Furthermore, to increase the present study's accuracy and objectivity, two college professors, licensed teachers completing their doctoral degrees, were invited to review the findings and provide suggestions. Their input was incorporated into the final results. One of the professors is a registered guidance counselor, and the other is a registered psychologist. Consensus coding and a review of the themes and subthemes were conducted. Additionally, the researcher's observations and textual descriptions from the students' essays were included to finalize the themes and subthemes for each research question.

Trustworthiness of the Research

Various strategies were implemented to ensure the research's validity and reliability. The researcher followed the four criteria Lincoln and Guba (1985) outlined to guarantee the trustworthiness of qualitative investigations. These criteria are explained in detail below.

Credibility

Patton (2002) identified three critical elements of credibility in qualitative research: rigorous methods, a credible researcher, and a belief in qualitative inquiry. Achieving rigor in research can be ensured through various methods, such as extended engagement with participants, researcher reflexivity, member checks, triangulation, and peer debriefing. All five were used in the current study and are described below.

The researcher of the present study spent additional time with participants to validate the information gathered during interviews. The increased time built trust in the data. It allowed both the researcher and participants to clear up any misunderstandings and add any information that may have been overlooked during the initial interview.

Reflexivity allows the researcher to detect ethical concerns throughout the research (Kleinsasser, 2000). Qualitative researchers understand that bias can play a part in their studies, but they need to acknowledge this bias early on. Reflexivity was utilized in this study by

detailing the researcher's role and maintaining researcher field notes (observation) to capture any thoughts and emotions that might influence the data throughout the study.

It is also crucial to check with members in order to increase the credibility of research, as stated by Lincoln and Guba (1985). Therefore, the researcher shared the present study's findings with the participants and let them suggest changes if they wanted more from her interpretation. Moreover, direct excerpts were given to participants to enable them to understand the findings.

The point of triangulation is to test for consistency between multiple sources of data even though it may not lead to a single answer (Patton, 2002). Triangulation was accomplished in this study through the use of multiple sources of data collection, including interview transcripts, essay, and the researcher field notes (observation).

Lastly, the researcher considered that some participants might feel distressed during or after the study. Participants were informed that they could withdraw or discontinue the interview if they experienced any discomfort without impacting their relationship with the researcher. The researcher provided a debriefing to the participants after the interview.

Transferability

According to Morrow (2005), transferability can be achieved through detailed information about the researcher, context, processes, and participants. The researcher focused on observations before, during, and after the focus group interviews that added richness to the data. The participants selected for this study were chosen through a purposeful sample. The specific type of purposeful sample was criterion sampling. Anfara and colleagues (2002) mentioned using purposeful sampling and thick descriptions to help ensure transferability.

Dependability

The dependability of a qualitative study is achieved through consistency and by developing an audit trail (Morrow, 2005). The audit trail for this study was documented carefully in the researcher's field notes throughout the research. Triangulation was also used with dependability, as mentioned under credibility. Data are more dependable when gathered from a variety of sources.

Confirmability

Confirmability describes the ability of the researcher to bring all data gathered and to be able to trust their findings. The overall findings of the study must reflect the actual information learned. To have confirmable results, researchers must reduce bias in their results (Morrow, 2005). This was accomplished in this study through triangulation, as mentioned previously, of three primary data sources. Combining the focus group interview data, field notes, and a reflexive journal, the data was continually examined to be trustworthy and confirmable.

Ethical Considerations

Since a qualitative study is an in-depth examination of the personal experiences of the participants, the following precautions were taken into consideration to protect the participant's rights: 1) acquiring approval from the research ethics office of the participating university, 2) communicating the purpose of the research to the participants in writing, as well as collecting informed consent and assent forms from minors, 3) ensuring participant anonymity through the use of pseudonyms, and 4) maintaining strict confidentiality of all personal information shared.

The researcher acknowledged that some participants might feel distressed during or after the focus group discussion. Participants were told they could withdraw or discontinue at any time if they felt uncomfortable without affecting their relationship with the researcher. After the interview, the researcher provided a debriefing to the participants. Data privacy was ensured through anonymization and aggregate presentation of results.

Results

Analysis of data revealed the lived experiences of first-year engineering students in terms of their academic and social adjustments in a hybrid setting. The initial phase of the phenomenological analysis of the statements is found in the transcripts (student's essay), which offer details about the participants' actual experiences.

Table 2 presents significant statements gathered from first-year engineering students about their academic and social adjustments toward hybrid learning. Participants expressed that hybrid classes were better rather than pure online classes during the pandemic. As seen in the table above, one participant stated,

> "I could say that the hybrid classes are actually far better than having full online classes like during the pandemic. And having full face to face classes since it makes the students' time flexible and not having to bother going back and forth in the campus, which increases efficiency".

Most participants expressed that there were still pros and cons of hybrid classes. For example, one participant shared,

> "I think one of the biggest disadvantages now…based on my personal experiences and what I hear from other froshies as well is that there are days where f2f classes are right after online classes. As a result, students like me who commute would still have to go to school early despite the online class, even if their f2f classes are later on. Though this may seem like a minor inconvenience, it can be really draining".

Overall, students' essays about their academic and social adjustment stressed both the advantages and disadvantages of the hybrid setting. Students were trying their best to adapt

and take advantage of the opportunity hybrid classes were offering them while also recognizing the challenges they had to deal with and work through.

Table 2

Participants Significant Statements in the Essay

Significant Statements in the Essay
"Academic adjustment is still somehow above the average than last semester since going back to face-to-face classes felt somewhat new after the pandemic resided"
"I could say that the hybrid classes are actually far better than having full online like during the pandemic. And having full face to face classes since it makes the students' time for flexible and not having to bother going back and forth in campus which increases efficiency"
"For me, the advantages of hybrid class are you wouldn't have to worry about spending a lot of money for food or transportation since there will be times when you will stay at home"
"Being able to schedule myself efficiently to do schoolwork's and learning at a comfortable pace."
"Most of the students still go to campus to attend only one class with face to face and the rest being online. For me, I think this is a disadvantage since it contradicts the idea of having the flexible time that both students and staffs."
"I think one of the biggest disadvantages now (based on my personal experiences and what I hear from other froshies as well) is that there are days where f2f classes are right after online classes. As a result, students like me who commute would still have to go to school early despite the online class, even if their f2f classes are later on. Though this may seem like a minor inconvenience, it can be really draining."
"I still haven't joined any organizations since I'm still trying to test the waters but as soon as I become more adjusted"
"I would say that my home org rarely has activities that would allow me to meet upperclassmen to ask for advice and help and make friends, which is why I know so little people in my course."
"Hopefully engineering department has more events that will make college life less "serious and technical" and enjoyable, as it is in these events where students will really remember throughout the years."
+25 other significant statements

In Table 3, four main themes were generated from the focus group interviews of first-year engineering students. Generally, participants expressed the idea that hybrid learning provides a flexible learning environment in which there is less academic fatigue. They felt hybrid learning saves both time and money. They also saw it as an opportunity to have a comfortable learning pace, and it is convenient from any location. One participant, Harvey (BS Civil), stated,

> "I think the advantages of hybrid classes is that me not going to school every day. In a week I go to school for at least 2-3 times. Then for the rest, I just stay at home for my online classes. I really like this because not only does it saves me from commuting and needing to go to school, it saves a lot of my energy. Being well rested allows me to even be more attentive and participative. As a student, hybrid learning is the best type of set up, since pure f2f classes can be draining and pure online classes isn't always effective".

Adaptability to technology was also identified. Participants expressed that in hybrid learning, they were becoming more tech-savvy and integrating synchronous and asynchronous learning. Another participant, Ana (BS IE), described, *"Our generation now are into technology and internet, and I can say that the hybrid learning allows us to become even more tech-savvy."*

The other theme that was generated was embracing a new education setup. Participants recognized that despite the many challenges that the pandemic brought, it opened up other opportunities for students and the educational system as a whole. Participants in the present study identified that the experience helped them adjust when faced with learning adversity. Jana (BS Che) explained,

> "The hybrid class this time maximized the advantages of both worlds. As a student, the experience during the pandemic gave a lot of insight also on how to survive -what would be helpful and how to continue".

Lastly, participants also pointed out that even though hybrid learning provided a flexible learning experience, they also reiterated that class scheduling, for some, defeated the purpose. It was stressed by James (BS ME) saying,

> "First of all, inconvenience, especially when there will be an urgent announcement that all classes will be shifted online, then you are already at school without your resources (laptop in my case since I don't bring my laptop whenever I have face to face classes). Second, it's very tiring as someone who is leaving far from the university."

While Carlo (BS ECE) shared similar sentiments, stating,

> "Same with my lab classes, they did not put the online lab classes together, which means I have to go to school on two separate days instead of one. But since this is

> beyond my control and is now past the half of the term, I really have to work on my schedule."

The lived experiences of first-year engineering students' academic adjustments toward hybrid learning showed that the online modality was integral to student learning, making it flexible and inclusive. However, combining online and in-person classes on the same day can add to the challenge of transitioning. Solving these challenges can help first-year engineering students achieve a smooth academic transition.

Table 3

Themes and Sub-Themes of First-Year Engineering Students' Academic Adjustments Toward Hybrid Learning

Theme	Sub-theme
Flexible Learning	Less academic fatigue
	Saving both time and money
	Opportunity to have a comfortable learning pace
	Convenient from any location
Adaptability in Technology	Becoming tech-savvy
	Integration of synchronous and asynchronous learning
Embracing New Education Setup	Able to adjust when faced with learning adversity
	Accepting changes and moving forward
Class Schedule	Difficulty having face-to-face and online class in a day

Table 4 presents the themes and sub-themes of first-year engineering students' social adjustment toward hybrid learning. There were two main themes and sub-themes. Participants identified both the advantages and disadvantages of hybrid learning in their social adjustment but highlighted less interaction and support. Chino (BS MEM) mentioned,

> "I think the main advantage would be having more social interaction among other students in the campus. Even though through online setting, there are still ways to socially interact since we have all adjusted from online setting during the pandemic. Although a disadvantage would be having less physical interaction and also having less time going out with peers inside and outside of campus and since we are froshies, most of us are shy and adjusting."

Similarly, another participant, Rafael (BS CIV), expressed,

> "It is difficult to make friends and build relationships with others since there are times when we won't be able to meet or see each other…only face to face twice a week. It

> will also be hard to adjust and adapt to the new environment if it is not always on a consistent basis."

Participants also identified that when it comes to social support, it would be best if they have someone with them, particularly since they are starting to adapt to the new environment as first-year students. It was expressed and reiterated by Joy (BS IE), who stated,

> "I would say that my home organization rarely has activities that would allow me to meet upperclassmen to ask for advice and help and make friends, which is why I know so little people in my course."

The social adjustment identified by first-year engineering students focused on the lack of social interaction and social support. Social experiences play a crucial role in well-being in general, but especially for first-year college students entering an entirely new environment where they might not know many people. First-year engineering students pointed out that the social adjustment process can greatly impact the success of transitioning.

Table 4

Themes and Sub-Themes of First-Year Engineering Students' Social Adjustments Toward Hybrid Learning

Theme	Sub-theme
Interaction	Less physical and social interaction
	Limitations in meeting other batchmates
Support	Lack of emotional connection
	Minimal activities from home organizations

Discussion

The process of adjustment entails changing one's behavior to work more harmoniously in a situation that has changed. As such, the transition from high school to college marks a critical period of adjustment for first-year students. At present, the trend to integrate face-to-face and online learning in the post-pandemic era, is also part of the transition among first-year student. Literatures acknowledge both the advantages and disadvantages of hybrid settings (Firmante, 2022). Students can experience learning opportunities and challenges in both educational modalities. Hybrid learning may lead to more independent learning and more opportunities for everyone to pursue education at any time or location. In-person instruction allows students to communicate directly with their teachers and peers. At the same time, online time allows students to interact with numerous resources and materials that could assist them in understanding particular ideas and improving their learning at their own pace (Brown, 2016). However, these changes can be challenging at the same time. The results of the present study confirm these documented opportunities and challenges.

First-year engineering students have identified opportunities and challenges related to their academic and social adjustments. The four main themes regarding the academic adjustment of first-year engineering students show that they have identified advantages and disadvantages of hybrid learning. For academic adjustments, participants expressed flexibility, being adept with technology, and being able to adjust to adversity. Conversely, the remote learning environment has also brought new educational opportunities (Hoss et al., 2022; Li et al., 2022). Students can access various digital resources, including open educational resources, research databases, and online libraries through hybrid learning. These materials can motivate students' creativity by introducing them to fresh concepts, viewpoints, and data (Haleem et al., 2022). For instance, Azorín (2020) argued that the crisis provided scarce opportunities to trial, improve, and rethink the role, content, and innovative education delivery methods. Despite this, it is also important to note that participants stressed the difficulty of having both an online and face-to-face schedule in a single day. The participants expressed that it would have been better if their course schedules alternated (one full online day and one complete face-to-face day) to avoid academic fatigue. For study participants, addressing concerns about course scheduling could be an adjustment that might be vital to their academic fulfillment.

Regarding social adjustment, participants expressed limitations, although they used social media for communication and interaction. Participants pointed out that there were still limitations regarding social interaction and social support. They expressed difficulty connecting with their classmates, as well as their professors. Some participants mentioned there was no connection at all. Most of them described a lack of support. This is important because Tindle and colleagues (2022) argued that social support is essential for accepting and navigating challenging circumstances. Social connections and the bonds that students have with their teachers and fellow students are crucial to higher education because they give students a feeling of community and enhance their online learning experience (Händel et al. 2020). As such, the difficulties in building social relationships online (Wilson et al., 2020) are vital areas that need to be addressed.

Moreover, the results of the present study are crucial in the post-implementation phase of this action research. Interventions should be available for students to address their academic, personal, career, and even psychological needs exacerbated by the pandemic. Intensifying counseling and other support services could be available at the university (Firmante, 2022). In addition, guidance is a process that consists of services offered to students to help them acquire the information and abilities required to make appropriate decisions, plans, and interpretations necessary for a satisfactory transition in various contexts (Sindabi, 1991). As such, the guidance and counseling programs in higher education institutions address the needs of students to enhance their adjustment to the immediate environmental challenges that affect their social growth and academic adjustment, especially in this post-pandemic time. Participants highlighted the lack of social interaction and support in their college transition. They said having more activities from their professional organizations could have helped. In this way, there would be opportunities to meet, collaborate, and seek assistance from seniors that might help them cope socially and even with their academic transition. Furthermore, this result will be the primary goal in program development for the post-implementation phase.

Conclusions and Implications

Hybrid learning is an integration of both face-to-face and online education modalities. This educational setup corresponds to the shift brought about by COVID-19 and continuously evolving in the post-pandemic era. Megahed and Ghoneim (2022) claimed that combining technology with in-person lectures creates settings that can improve students' capacity for learning. Hence, the educational shifts and lessons learned during the pandemic are suitable for the post-pandemic transition. Therefore, to provide meaningful and engaging transition experiences to first-year engineering students, building appropriate supports should be addressed.

Hence, this action research explored the experiences of first-year engineering students' academic and social adjustment toward hybrid learning. The goal was to better understand their specific needs and how they can be addressed in their transition. The primary goal was to develop a program that will support the smooth transition of first-year engineering students to hybrid learning contexts. The findings of this study are crucial for the post-implementation phase of this action research, especially in the counseling profession, where evidence-based programs are vital.

Limitations of the Study

By design, this action research was meant to explore first-year engineering students' academic and social adjustment as the basis for program development. It highlighted their experiences in the hybrid education setting post-pandemic. However, this study is limited to a specific group within a particular context, making it difficult to generalize the findings. The focus group was also conducted purely online. Conducting the focus groups in a face-to-face context may have yielded different results. Furthermore, the essay was a class requirement, which might have influenced how candid and open students were in their responses.

References

Alipio, M. (2020). Academic Adjustment and Performance among Filipino Freshmen College Students in the Health Sciences: Does Senior High School Strand Matter? https://doi.org/10.35542/osf.io/xq4pk

Alfiras, M., Nagi, M., Bojiah, J., & Sherwani, M. (2021). Students' Perceptions of Hybrid Classes in the Context of Gulf University: An Analytical Study. *Journal of Hunan University Natural Sciences*, *48*(5).

Al-Qaisy, L. M. (2010). Adjustment of college freshmen: The importance of gender and the place of residence. *International Journal of Psychological Studies*, *2*(1), 142. https://doi.org/10.5539/ijps.v2n1p142

Anderson, J. R., Guan, Y., & Koc, Y. (2016). The academic adjustment scale: Measuring the adjustment of permanent resident or sojourner students. *International Journal of Intercultural Relations*, *54*, 68–76. https://doi.org/10.1016/j.ijintrel.2016.07.006

Anfara, V. A., Brown, K. M., & Mangione, T. L. (2002). Qualitative analysis on stage: Making the research process more public. *Educational Researcher, 31*(7), 28–38. https://doi.org/10.3102/0013189X031007028

Ang, J. Y. Z., Monte, V., & Tsai, W. (2022). First-year college students' adjustment during the COVID-19 pandemic: The protective roles of hope and gratitude. *Translational Issues in Psychological Science*. https://doi.org/10.1037/tps0000320

Azorín, C. (2020). Beyond COVID-19 supernova. Is another education coming?. *Journal of Professional Capital and Community*, *5*(3/4), 381–390. https://doi.org/10.1108/JPCC-05-2020-0019

Baker, R. W., & Siryk, B. (1989). Student adaptation to college questionnaire. In *Program of the Seventy-Fourth Annual Meeting*.

Baltà-Salvador, R., Olmedo-Torre, N., Peña, M., & Renta-Davids, A. I. (2021). Academic and emotional effects of online learning during the COVID-19 pandemic on engineering students. *Education and Information Technologies*, 1–28. https://doi.org/10.1007/s10639-021-10593-1

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-77–101. https://doi.org/10.1191/1478088706qp063oa

Brown, M. G. (2016). Blended instructional practice: A review of the empirical literature on instructors' adoption and use of online tools in face-to-face teaching. *The Internet and Higher Education*, *31*, 1–10. https://doi.org/10.1016/j.iheduc.2016.05.001

Bubb, S., & Jones, M. A. (2020). Learning from the COVID-19 home-schooling experience: Listening to pupils, parents/carers and teachers. *Improving Schools*, *23*(3), 209–222. https://doi.org/10.1177/1365480220958797

Clinciu, A.I. (2012). Adaptation and stress for the first year university students. *Procedia-Social and Behavioral Sciences, 78*, 718–722. https://doi.org/10.1016/j.sbspro.2013.04.382

Clinciu, A. I., & Cazan, A.M. (2013). Academic adjustment questionnaire for the university students. *Procedia-Social and Behavioral Sciences*, *127,* 655–660. https://doi.org/10.1016/j.sbspro.2014.03.330

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, *49*(1), 5–22. https://doi.org/10.1177/0047239520934018

Dorn, E., Hancock, B., Sarakatsannis, J., & Viruleg, E. (2020). COVID-19 and student learning in the United States: The hurt could last a lifetime. *McKinsey & Company*, *1*.

Enochs, W. K., & Roland, C. B. (2006). Social adjustment of college freshmen: The importance of gender and living environment. *College Student Journal*, *40*(1).

Grodotzki, J., Upadhya, S., & Tekkaya, A. E. (2021). Engineering education amid a global pandemic. *Advances in Industrial and Manufacturing Engineering*, *3*, 100058. https://doi.org/10.1016/j.aime.2021.100058

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, *3*, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Händel, M., Stephan, M., Gläser-Zikuda, M., Kopp, B., Bedenlier, S., & Ziegler, A. (2020). Digital readiness and its effects on higher education students' socio-emotional perceptions in the context of the COVID-19 pandemic. *Journal of Research on Technology in Education*, *54*(2), 267–280. https://doi.org/10.1080/15391523.2020.1846147

Hodges, C. B., Moore, S., Lockee, B. B., Trust, T., & Bond, M. A. (2020). The difference between emergency remote teaching and online learning.

Hoss, T., Ancina, A., & Kaspar, K. (2022). German university students' perspective on remote learning during the COVID-19 pandemic: a quantitative survey study with implications for future educational interventions. *Frontiers in Psychology*, *13*, 734160. https://doi.org/10.3389/fpsyg.2022.734160

Jacques, S., Ouahabi, A., & Lequeu, T. (2020). Remote Knowledge Acquisition and Assessment During the COVID-19 Pandemic. *International Journal of Engineering Pedagogy, 10*(6), 120. https://doi.org/10.3991/ijep.v10i6.16205

Jindal-Snape, D., & Rienties, B. (2016). Understanding multiple and multi-dimensional transitions of international higher education students: setting the scene. In *Multi-dimensional Transitions of International Students to Higher Education* (pp. 21–38). Routledge. https://doi.org/10.4324/9781315680200-8

Jones, R. L. (1966). The College Adjustment of Superior High School Students Who Participated in a Program of Acceleration. *Exceptional Children*, *32*(9). https://doi.org/10.1177/001440296603200911

Li, J., Huang, X., Lei, X., Wen, J., & Lu, M. (2022). ICT literacy, resilience and online learning self-efficacy between Chinese rural and urban primary school students. *Frontiers in Psychology*, *13*, 1051803. https://doi.org/10.3389/fpsyg.2022.1051803

Lincoln, YS., & Guba, E.G. (1985). Naturalistic inquiry. Newbury Park, CA: Sage. https://doi.org/10.1016/0147-1767(85)90062-8

Kleinsasser, A. M. (2000). Researchers, reflexivity, and good data: Writing to unlearn. *Theory Into Practice, 39*(3), 156–162. https://doi.org/10.1207/s15430421tip3903_6

Kitzinger, J. (1995). Qualitative research: introducing focus groups. *BMJ*, *311*(7000), 299–302. https://doi.org/10.1136/bmj.311.7000.299

Ko, S. H., & Lee, J. Y. (2013). The influence of college students club activities in school life resilience: Testing mediation model of social support. *Welfare Counseling Edu Research*, *2*(1), 35–51.

Martínez, P. J., Aguilar, F. J., & Ortiz, M. (2019). Transitioning from face-to-face to blended and full online learning engineering master's program. *IEEE Transactions on Education*, *63*(1), 2–9. https://doi.org/10.1109/TE.2019.2925320

McCabe, J. M. (2016). Connecting in college. In *Connecting in College*. University of Chicago Press. https://doi.org/10.7208/chicago/9780226409665.001.0001

McGee, P., & Reis, A. (2012). Blended course design: A synthesis of best practices. *Journal of Asynchronous Learning Networks*, *16*(4), 7–22. https://doi.org/10.24059/olj.v16i4.239

Megahed, N., & Ghoneim, E. (2022). Blended learning: the new normal for post-Covid-19 pedagogy. *International Journal of Mobile and Blended Learning (IJMBL)*, *14*(1), 1–15. https://doi.org/10.4018/IJMBL.291980

Mills, G. E. (2000). *Action research: A guide for the teacher researcher*. Prentice-Hall, Inc., One Lake Street, Upper Saddle River, New Jersey 07458.

Montgomery, S., Gregg, D. H., Somers, C. L., Pernice-Duca, F., Hoffman, A., & Beeghly, M. (2019). Intrapersonal variables associated with academic adjustment in United States college students. *Current Psychology*, *38*(1), 40–49. https://doi.org/10.1007/s12144-016-9533-0

Morrow, S. L. (2005). Quality and trustworthiness in qualitative research in counseling psychology. *Journal of Counseling Psychology, 52*(2), 250–260. https://doi.org/10.1037/0022-0167.52.2.250

National Academies of Sciences, Engineering, and Medicine. (2017). *Supporting students' college success: The role of assessment of intrapersonal and interpersonal competencies*. Washington, DC: National Academies Press.

Nortvig, A. M., Petersen, A. K., & Balle, S. H. (2018). A Literature Review of the Factors Influencing E-Learning and Blended Learning in Relation to Learning Outcome, Student Satisfaction and Engagement. *Electronic Journal of E-learning*, *16*(1), 46–55.

Park, J. J., Park, M., Jackson, K., & Vanhoy, G. (2020). Remote Engineering Education under COVID-19 Pandemic Environment. *International Journal of Multidisciplinary Perspectives in Higher Education*, *5*(1), 160–166. https://doi.org/10.32674/jimphe.v5i1.2811

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage.

Ponterotto, J. G. (2005). Qualitative research in counseling psychology: A primer on research paradigms and philosophy of science. *Journal of Counseling Psychology*, *52*(2), 126. https://doi.org/10.1037/0022-0167.52.2.126

Powell, A., Watson, J., Staley, P., Patrick, S., Horn, M., Fetzer, L., ... & Verma, S. (2015). Blending Learning: The Evolution of Online and Face-to-Face Education from 2008-2015. Promising Practices in Blended and Online Learning Series. *International association for K-12 online learning*.

Reddy, K. J., Menon, K. R., & Thattil, A. (2018). Academic stress and its sources among university students. *Biomedical and Pharmacology Journal*, *11*(1), 531–537. https://doi.org/10.13005/bpj/1404

Sahin, S., Arseven, Z., & Kiliç, A. (2016). Causes of Student Absenteeism and School Dropouts. *International Journal of Instruction*, *9*(1), 195–210. https://doi.org/10.12973/iji.2016.9115a

Shim, S. S., & Ryan, A. M. (2019). Social achievement goals. In *Social Goals in the Classroom* (pp. 53–73). Routledge. https://doi.org/10.4324/9780429468452-4

Sindabi, A.M. (1992). An Analysis of *The Guidance and Counselling Program in Selected Kenyan Secondary Schools*. Unpublished Ed. Dissertation, Virginia Polytechnic and State University, Falls Church Virginia.

Singh, J., Matthees, B., & Odetunde, A. (2021). Leaning online education during COVID-19 pandemic–attitudes and perceptions of non-traditional adult learners. *Quality Assurance in Education*, *29*(4), 408–421. https://doi.org/10.1108/QAE-12-2020-0147

Stephens, N. M., Brannon, T. N., Markus, H. R., & Nelson, J. E. (2015). Feeling at home in college: Fortifying school-relevant selves to reduce social class disparities in higher education. *Social Issues and Policy Review*, *9*(1), 1–24. https://doi.org/10.1111/sipr.12008

Terenzini, P. T., Rendon, L. I., Lee Upcraft, M., Millar, S. B., Allison, K. W., Gregg, P. L., & Jalomo, R. (1994). The transition to college: Diverse students, diverse stories. *Research in Higher Education*, *35*(1), 57–73. https://doi.org/10.1007/BF02496662

Tindle, R., Hemi, A., & Moustafa, A. A. (2022). Social support, psychological flexibility and coping mediate the association between COVID-19 related stress exposure and psychological distress. *Scientific Reports*, *12*(1), 8688. https://doi.org/10.1038/s41598-022-12262-w

Thomas, L., MacMillan, J., McColl, E., Hale, C., & Bond, S. (1995). Comparison of focus group and individual interview methodology in examining patient satisfaction with nursing care. *Social Sciences in Health*, *1*(4), 206–220.

Ulla, M. B., & Perales, W. F. (2022). Hybrid teaching: Conceptualization through practice for the post COVID19 pandemic education. *Front. Educ*, *7*, 924594. https://doi.org/10.3389/feduc.2022.924594

Ulla, M. B., & Perales, W. F. (2021). Emergency Remote Teaching During COVID19: The Role of Teachers' Online Community of Practice (CoP) in Times of Crisis. *Journal of Interactive Media in Education*, *2021*(1). https://doi.org/10.5334/jime.617

Van Viet, V. (2021). Student's adjustment to university and its relation to gender, residence and family factors. *Kasetsart Journal of Social Sciences*, *42*(1), 81–88. https://doi.org/10.34044/j.kjss.2021.42.1.13

Wilson, S., Tan, S., Knox, M., Ong, A., Crawford, J., & Rudolph, J. (2020). Enabling cross-cultural student voice during COVID-19: A collective autoethnography. *Journal of University Teaching and Learning Practice*, *17*(5). https://doi.org/10.53761/1.17.5.3

Corresponding author: Maria Cristina Firmante
Email: maria.cristina.firmante@dlsu.edu.ph

The Influence of E-Comics on English Lexical Competence in Virtual Higher Education

Norma Flores-González
Universidad Autónoma de Puebla, México

Vianey Castelán Flores
Universidad Autónoma de Puebla, México

Mónica Zamora Hernández
Universidad Autónoma de Puebla, México

Abstract

The development of lexical competence in foreign languages is one of the skills that presents difficulties in the teaching-learning process, as it requires stimulation and retention on the part of the student and creativity from the teacher. In this sense, digital resources emerge as a conducive means to promote new knowledge and consolidate acquired vocabulary. In this context, the present research aimed to determine if digital comics influence the development of lexical competence in English in virtual environments at the higher education level. Methodologically, an experimental design divided into three phases (pre-treatment, treatment, and post-treatment) took place with a sample of 60 students during the autumn of 2023. The results demonstrated an association between digital comics and lexical competence development variables, influencing lexicon acquisition, experiencing creativity, dynamism, and language involvement. Besides, comics supported by Canva, Makebeliefscomix, and Pixton applications contributed to students' cultural, linguistic, and communicative repertoire. Concurrently, users' confidence increased through gradual and systematic recovery, use, and inventive writing activities. Supports such as images, dialogues, characters, and colors encouraged the retrieval of words for subsequent use. In this way, the cognitive process of recall ceased to be merely memorising to transition to a level of long-term significant comprehension. In conclusion, digital comics were plausible for encouraging practical, flexible, and playful vocabulary improvement in a virtual environment.

Keywords: lexical competence, e-comics, virtual learning, applications, foreign language

Learning a foreign language involves the development of various linguistic, cultural, and social skills related to the language, as it is the means through which a speaker interacts and connects with the outside world. Among the skills required for authentic communication is vocabulary acquisition because it allows access to a wide range of information and generates fluid dialogue. In this context, the Faculty of Languages from the Benemérita Universidad Autónoma de Puebla in the area of English aims for students to primarily develop communicative competence, as one of the most frequent limitations is the reduced lexical repertoire for expression, which limits the possibilities of effective oral interaction. Besides, after adding the virtual component, students' participation decreases due to a lack of word knowledge, contextual understanding, and confidence to speak in public. In these environments, the need to produce didactic resources and active environments leads to innovative and meaningful activities for the participants. Thus, facing various educational modalities, the aim is to address lexical weaknesses to benefit foreign language students.

From this context, the purpose of this paper is to identify whether the development of lexical competence is influenced by the use of e-comics in virtual environments in higher education. In foreign language didactics, the desire to innovate and address this educational issue gives rise to the design, development, and use of various strategies and resources that provide the necessary stimulus for students to understand and appropriate new knowledge. Therefore, digital resources emerge as a means to meet these teaching-learning needs of the target language. The use of digital comics with applications such as Canva, Makebeliefscomix, and Pixton is proposed to enable gamified learning with a communicative approach, allowing contact with the foreign language in an appealing, motivating, and flexible manner, generating contextualized language practice for the user. In this sense, such tools promote activities with a communicative focus to appropriate the lexicon. Along with this dynamic resource, the comic strip is incorporated as one of the educational supports with high stimulation and creativity. Indeed, it represents one of the cultural elements of contemporary society and Generation Z.

Considering the organization of this research, the sections include 1) Theoretical Framework, where the main conceptual foundations are presented. 2) Methodology, which analyzes lexical competence. 3) Results, which describe the evaluation of the proposed pedagogical intervention with data. 4) Discussion, 5) Recommendations, derived from the study, 6) Conclusions, and 7) References.

Theoretical Framework

Origins of lexical competence in the foreign language didactics, is found in the works of linguists such as Chomsky with his semantic analysis of corpus (Barón et al., 2013), and Hymes with his ethnographic studies of language, framing the lexicon from its context, usage, and intention (Roselló, 2021). However, it was not until the publication of Michael Lewis's book in 1993, *The Lexical Approach: The State of ELT and a Way Forward*, that importance was given to the study of the lexicon in foreign language didactics, as this work highlights it as an essential component in language learning, especially in the development of communicative competence. Following Lewis's contribution, studies have focused on viewing the lexicon not as a series or list of words learned randomly but rather as a competence, involving the speaker's

knowledge and skills that make them competent to interact effectively in oral or written communication (De la Maya & López-Pérez, 2021; Castillo et al., 2022; Marin-Marin & Hernández-Romero, 2022).

In more recent studies, the most researched topics are those that explain what linguistic competence is and how it develops, such as the works of Alejos (2017), Rodríguez-Montes (2020), and Pasuy & Agudelo (2022), which focus on analyzing the development of lexical competence through linguistic, semantic, and sociolinguistic approaches to understand the importance of word usage in authentic contexts. Other works, such as those by Onieva-Palomar (2019) and Robles (2018), highlight the importance of mastering the lexical factor as a didactic strategy for effective foreign language learning. However, there are also more specific studies, such as those by Cáceres et al. (2018), Valdés-León (2021), and Zambrano & García (2022), that explain how the effective development of lexical competence supports the enhancement of literacy skills. In the particular case of this research, the situation that prompted the study deals with a very recurrent problem in the development of communicative competence.

The knowledge of the lexicon has three dimensions: form, meaning, and use (Sanhueza et al., 2018). In the Common European Framework of Reference (CEFR), the lexical component associated in the first instance with linguistic competence links it to both pragmatic and sociolinguistic ones. It emphasizes the speaker's capacity in terms of two dimensions: richness and mastery of vocabulary. Richness is the size of vocabulary acquired in the language learning process through stimulus (input) and production (output) from daily interactions of each communicative activity. Besides, the mastery of the lexicon refers to the assimilation and association processes presented at each of the syntactic and semantic levels that occur when structuring words to form messages (Consejo de Europa, 2020). For his part, Robles (2018) mentions that the lexicon is an essential element for the mastery and linguistic development of a language since it allows the effective development of comprehension and oral expression skills.

Regarding its teaching, Torres & Aristu (2021) assert that beyond understanding cognitive processes, word dimensions, and strategies for learning and usage, it is essential to consider the speaker's identity, focusing specifically on the learner's areas of knowledge, interests, and personal relationships; thus, contextualized vocabulary learning is unavoidable. In his study, Beghadid (2022) classifies the vocabulary: 1. Technical vocabulary that deals with a particular disciplinary area, including its idioms and technical terms. 2. General vocabulary that consists of words used to name everyday activities commonly known by everyone. 3. Potential vocabulary is a set of words usually unknown to the student but whose meanings can be inferred or understood through their relationship with other known words or by context. 4. Passive vocabulary that is known but not frequently used in routine interactions. 5. Active or productive vocabulary is the lexicon a student constantly employs in their oral and written productions.

Strategies for Learning Vocabulary

Mastery of a language must adhere to both theoretical and practical aspects of vocabulary usage (Guerrero et al., 2022). For this reason, it is of utmost importance to have didactic strategies that are cognitive and socio-affective, including memorization, organizational, and motivational aspects (Gómez et al., 2021) to help learners acquire new vocabulary. Beghadid (2022) indicates that students often use three memorization skills to learn new vocabulary: visual, auditory, and kinesthetic. These strategies enhance the integration and recall of new words and their association (Berthely et al., 2023). Moreover, organizational and motivational strategies act as triggers for meaningful vocabulary learning. From a communicative-functional approach, reading comprehension tasks and academic and creative writing are used, as these contextual references stimulate the need to acquire vocabulary to interact correctly in a real communication task (García et al., 2020).

However, when discussing vocabulary learning strategies, it is impossible to overlook the classification by Levin & Pressley (cited in García-López, 2000) because most research dedicated to identifying strategy types has its basis in their studies. According to these authors, there are four groups of strategies: 1. Repetition Strategies are for students to repeat a list of words orally or in writing. 2. Sensory Strategies can be visual, tactile, or audiovisual, supported by materials such as vocabulary cards, images, and videos, to mention a few. 3. Semantic Strategies that focus on associating new vocabulary with previously learned words and analyzing their relationships for word memorization. Known semantic strategies include association, contextualization, imagery, and the morphosyntactic analysis of the word. 4. Mnemonic Strategies refer to all the resources or techniques students use to memorize a word.

García et al. (2020) classify vocabulary-learning strategies into three types: 1. Cognitive strategies. These are conscious activities to understand or learn vocabulary, such as repetition, reference materials, translation, grouping, note-taking, deduction, imagery, and keywords. 2. Communicative or compensatory strategies. These encompass all resources or techniques that aid in understanding the meaning of words, such as guessing, inference, association, exemplification, and questioning, among others. 3. Memorization strategies. These activities assist the student in remembering, understanding, and appropriating vocabulary, as well as comprehending meanings and recognizing new concepts within discourse to store them in their mental structure.

Technology-Mediated Vocabulary Learning

Technological advancements have opened a new way of interacting with knowledge, where images become a relevant element for knowledge transmission and communication within an educational context governed by telecommunications (Hernández et al., 2020; Flores, 2023). Furthermore, students are seen as digital natives who use mobile devices and digital applications for everything, meaning they see, know, and interact with their world through the web. Therefore, in teaching, it is fundamental to implement these digital tools to facilitate learning since cyberspace offers countless pedagogical and non-pedagogical resources in which any type of educational task can be developed significantly (Flores-González, 2020;

Ccoa & Alvites, 2021). Furthermore, Vargas-Murillo (2020) presents a classification that specifies educational strategies developed with digital technological tools used in virtual environments to work on the cognitive part of lexicon learning, which are:

- Conceptual-graphic-organizer strategies. They include concept maps for information retention and concept development. Mind maps for the construction and information management, creativity for taking notes and planning thoughts, and the semantic networks in which the meanings and interrelationships of words are for learning and enriching the lexicon. Some tools for this type of strategy are Draw.io, CmapTools, Microsoft Visio, Lucidchart, MindMeister, XMind, Creately, GitMind, ATLAS ti, and Inspiration.
- Visual-representation strategy. For example, infographics and illustrations that synthesize and encode information through texts, images, diagrams, and symbols. The information resources used for its design are Google Drawing, Piktochart, Canva Genially, Prezi, RealWorld Paint, and GIMP.
- Processing information strategies. They refer to three elements: (a) Interspersed questions, focused on feedback, resolution of doubts, and self-assessment; (b) summary, used in abstraction, synthesis, and reformulation to identify key ideas and concepts; and (c) narrative texts, whose function is the construction of mental and situational models through textual narrative, as well as literary creativity. Some digital tools for these strategies are Google Forms, Survery Monkey, Microsoft Forms, Resoomer, Text Summary, Google Docs, iA Writer, Penultimate, Celtx, Makebeliefscomix, and Pixton.

One of the disciplines that has most benefited from technology is foreign language didactics, as technological resources have been present in methodologies developed over time. In this sense, Borromeo et al. (2018) mention this in their study on the use and evolution of technology in foreign language teaching, stating that it was from the audio-lingual method onwards that technological resources and tools began to be exploited, even more so with the communicative method or approach, where the development of both communicative and digital competencies allows students to have experiences of ubiquitous, immersive, autonomous, and recreational learning (Trujillo et al., 2019).

The E-Comic Strip

The e-comic strip is a student-centered activity defined as a textual technique within the narrative genre, where stories are told through texts and images intentionally structured to evoke an aesthetic response in readers upon reading. This characteristic of combining text with images is one of the most outstanding features of comic strips, as it allows for the retention of information conveyed in each part of the narrative in a more substantial way (Mosquera & Rendón, 2021). For some authors, the origin of comic strips dates back to prehistory, with cave paintings, while others associate it with the invention of the printing press. However, it wasn't until 1894 that the comic strip as we know it today was born. The first comic strip was published in the New York World newspaper in 1876, featuring *The Yellow Kid*, where a narrative in panels depicting the life and actions of the characters, as well as descriptions of

their expressions, was presented (Maza, 2012). In 1920, comic strips transitioned from newspaper to formal publications. In 1938, the first standalone issue appeared featuring Superman. With this event, the true origin of comic strips, as we know them today, is established (Salinas, 2022).

The comic strip is considered a multimodal text where visually constructed experiences enable the understanding of culture (Pickel, 2018). Most authors agree that comic strips handle textual multimodality with elements such as panels, kinetic lines, visual metaphors, text, speech bubbles, images, perspectives, layout, and chromatic codes. Regarding the textual style, comic strips use satirical, lyrical, and aesthetic language to transmit the values and lifestyles of a particular society. They implement the structure of literary narrative where sequentiality in chapters or episodes is employed to give progression to the stories told (Cordero & Mejía, 2021). Besides, rhetorical figures predominate, enriching the texts with aesthetic resources to capture attention and interest (Vilches-Fuentes, 2019).

The e-comic strip can be employed as a didactic support tool in communication and culture. However, it is essential to develop narrative competence and reading ability in students based on the sociocultural elements of the language because its reading is not like any other. The decoding and interpreting process involves knowledge of the cultural-linguistic expressions and codes in which the comic strip was created (Flantrmsky, 2022). In foreign language teaching, the comic strip is considered a discursive technique that significantly enhances lexical learning and dynamizes the development of communicative competencies (Jiménez-Arriagada et al., 2020).

Moreover, in works such as those by Soto-Cano (2019) and Córdoba-Baldrich & Maturana (2022), the use of the comic strip is a resource for developing students' linguistic, pragmatic, and sociolinguistic competencies in a foreign language. They also see it as a mediator to encourage reading due to its attractive nature. Additionally, Huerta & Ortega (2021) emphasize its use to work on vocabulary and its retention through association and playful learning. Moreover, it aids in working on communicative activities of reception and production, both oral and written (Martínez, 2023). All these aspects together promote conscious vocabulary learning in an everyday context.

Methodology

To ascertain how the e-comics supported by the Canva, Makebeliefscomix, and Pixton applications influence the lexical competence development in a virtual environment at higher education, the present study uses an experimental design aimed at manipulating the independent variable (use of e-comics with three applications based on tasks) to observe its possible effect on the dependent variable [development of lexical competence (LC)] (Hernández-Sampieri & Mendoza, 2018). To this end, there is an experimental and a control group. To register how e-comics influence the LC, a techno-pedagogical model was applied in the experimental group to develop such LC using e-comics through Canva, Makebeliefscomix, and Pixton with three tasks. In contrast, the control group developed their LC with traditional methods, isolated from the proposed techno-pedagogical model. Finally, to test and verify the

plausibility of the proposal, pre-and post-treatment tests were administered to measure the effect of using e-comics with the applications for vocabulary learning. Therefore, the study is a cross-sectional quantitative study with an associative design based on the following hypothesis: The use of e-comics supported by Canva, Makebeliefscomix, and Pixton influences the development of LC in a foreign language in virtual environments.

Instruments: Pre-treatment, Treatment, and Post-treatment

The following instruments were used in the three phases:

- Pre and post-treatment. A standardized test was administered to measure the students' lexical repertoire, taking the CEFR levels as a reference to record the possible influence of e-comics after working with the techno-pedagogical design (treatment). It had a multiple-choice format, including filling in the blanks, unscrambling, and selecting the word that best fits a context.
- Treatment. A technology-mediated model was designed to teach vocabulary through e-comics using Canva, Makebeliefscomix, and Pixton according to three tasks based on the Technique Features Analysis (TFA) Model (see Table 3). It is hosted on the Moodle platform with hyperlinks to the Canva, Makebeliefscomix, and Pixton applications so that students can create comic strips based on three tasks and a set of 300 pre-specified words determined from the CEFR for Languages and according to the level corresponding to the critical path of the English Teaching Bachelor program. Table 1 shows the design of the techno-pedagogical model.

Table 1
Design of the Techno-Pedagogical Model

Tasks with applications	Target words	Implementation	Instruments to evaluate this phase	
Canva Makebeliefscomix Pixton	100 different words for each application (40 nouns, 40 verbs, and 20 adjectives)	25 words were worked per week in 3 two-hour sessions during a month for each application.	18 components from the TFA model to measure the lexical acquisition with apps based on tasks	Productive and receptive acquisition tests to measure students' LC with each application

Tasks for Each Application

Canva

1. Students carried out individual recreational activities for the presentation of keywords, their recovery, and memory (word search and crossword puzzles).

2. Subsequently, they used collaborative graphic organizers to categorize ideas, working on spaced recovery and the form-meaning union with the main ideas of the dialogues for the comic.
3. Finally, they elaborated the narrative outline individually, using the dialogues created in the previous classes to match them with the pre-designed images in Canva, allowing productive recovery and recognition of the mental representation of the concept. Thus, the students became aware of learning the new lexicon, stimulating their motivation for learning.

Makebeliefscomix

1. A collaborative reading of instructions was carried out, establishing the target lexical learning and the exemplification to elaborate on each part of the comic.
2. Each student developed their e-comic, choosing characters and settings to associate images with their stories to promote form-meaning identification, recovery, and memory.
3. Finally, the story is built by adding dialogue balloons in which attention to the keywords and spaced and productive recovery took place for the narrative thread, contributing to the awareness of learning new lexis and motivation towards the process.

Pixton

1. Students' attention was encouraged through an individual activity by highlighting the target words and clarifying the lexical learning objective to associate them with images to remember their meaning through the mental-lexical image. After that, students select the keywords for vocabulary recovery, representing their understanding through the form-meaning union.
2. Participants did a group activity called the use of context that consisted of multiple recoveries of the keywords in different exercises provided by the teacher like the construction and combination of sentences with exemplification, spaced recovery with gap filling, and productive recovery with the generation of simple texts
3. As a final activity, they individually wrote the narrative of the e-comic, taking into account the productive generation of the dialogues and the marking of keywords to be aware of the new vocabulary. Then, the students read aloud to identify the key ideas in their narratives and negotiated the correct use of words in the dialogues to avoid interference or confusion, contemplating the high degree of generation in the final evidence of their learning, enhancing their motivation in this task.

The activities were both individual and collaborative, based on active methodologies, gamification, and the use of technological applications. Besides, to evaluate the participants' LC in each implementation period, two instruments were used:

- Receptive and productive written tests were used to evaluate the three applications where every 100 words have a ten-weighted score in both instruments. The receptive test consists of a list of 100 target words for each application in English and asks the student to enter their meaning in Spanish. In contrast, the productive test contains the same target words in Spanish and asks the student to write them in English.

- In each task, the TFA model was used to identify which of the three applications promotes the most vocabulary learning, based on the premise that 1 means presence and 0 absence of each element belonging to five categories: motivation, notation, recovery, generation, and retention with a maximum of 18 points [see Table 3] (Nation & Webb, 2011).

Sample

Sixty first-semester students, the entire population of the English Teaching Bachelor of the Benemérita Universidad Autónoma de Puebla, who signed the informed consent form, participated in this research. Some of their characteristics are low proficiency level in communicative situations, lack of lexical background to interact in varied situations or contexts, and enrolled in virtual classes for six hours a week. Half of the students were randomly assigned to the control group and the rest to the experimental group.

Data Collection and Analysis

Data collection was done in three phases. Phase 1: Pre-treatment. This was administered at the beginning of the study and before the treatment to both the control and experimental groups to assess their level of lexical competence. Phase 2: Treatment. Data was collected only from the experimental group at the end of each implementation of the applications (Canva, Makebeliefscomix, and Pixton). First, the receptive test was administered individually. Subsequently, the teacher administered the TFA instrument as a group so that each student recognized the absence or presence of the 18 elements in each application task. Finally, each participant answered the productive test. Phase 3: Post-treatment. This was administered after the treatment to both groups and at the end of the 2023 semester to obtain a reference for evaluating the proposal and to corroborate the hypothesis. Table 2 presents the data analysis model used to display the results.

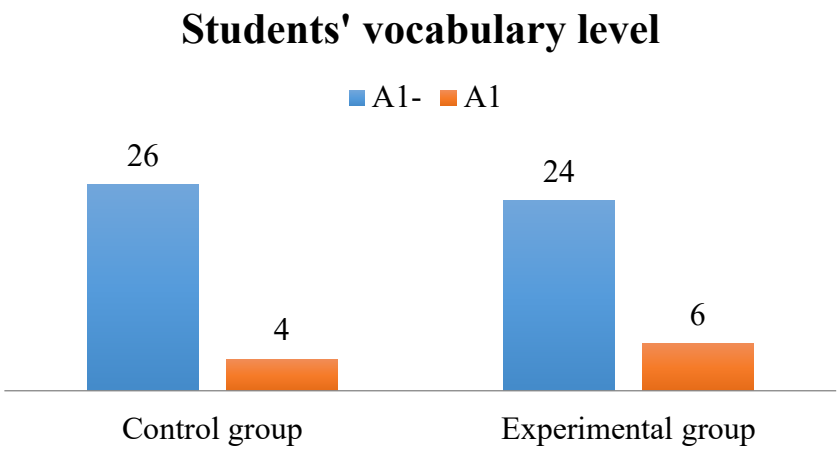
Table 2
Analysis Model. Own Elaboration

Phases	Purpose
Pre-treatment	Measure initial lexical competence
Treatment	Measure vocabulary learning from e-comic strips using the Canva, Makebeliefscomix, and Pixton applications
Post-treatment	Measure final lexical competence

Results

The following section presents findings related to participants' baseline LC, the results of LC according to the TFA model, the receptive and productive tests, and the post-treatment results to analyze and verify the influence of e-comics on LC.

Figure 1
Pre-Treatment Stage Results



As seen in Figure 1, in both groups, a majority of students are at level A1- (26 in the control and 24 in the experimental group), with only a few students at level A2 (4 in the control and 6 in the experimental group. The graph corroborates the background information on the participants, as it shows a lack of vocabulary diversity, resulting in the use of simple words and phrases that do not align with the level demanded by the course. It has led to poor communication, which can even cause misunderstandings. The results suggest a limited development of higher-level linguistic skills, impacting reading comprehension and written production. It underscores that a limited vocabulary hinders the successful expression and communication of ideas, affecting the student's confidence and motivation to communicate in the target language, in this case, English.

Treatment

Table 3
Components and Criteria of the Technique Feature Analysis (TFA) Model. Source: Nation and Webb, 2011.

		Number of students who perceived presence of element		
Criterion	**Explanation**	**Week 1-4 Canva**	**Week 5-8 Makebeliefs comix**	**Week 9-12 Pixton**
		N=30	**N=30**	**N=30**
Motivation				
1. Objective: lexical learning	Is there a clear objective for lexical learning?	2	**29**	**29**
2. Motivation toward learning	Do they motivate students?	**29**	**28**	**29**

3. Student word selection	Do students choose the words they will learn?	1	2	**30**
Noticing				
4. Attention to keywords	Does it encourage students to pay attention to keywords?	3	**27**	**30**
5. Awareness of new lexical learning	Does the activity make students aware they are learning new vocabulary?	**28**	**29**	**30**
6. Negotiation	Does the activity offer negotiation opportunities?	1	2	**29**
Retrievaal				
7. Retrieval	Does the activity provide retrieval opportunities?	**28**	**29**	**30**
8. Productive retrieval	Is there productive retrieval?	**29**	**29**	**30**
9. Recall	Does it involve recall?	**28**	**29**	**30**
10. Multiple retrievals	Does the activity involve multiple retrieval opportunities for each keyword?	1	1	**30**
11. Spaced retrievals	Does the activity lead to spaced retrievals?	**27**	**29**	**30**
Generation				
12. Generation	Does the activity promote generation?	2	**29**	**30**
13. Productive generation	Does the activity involve productive generation?	2	3	**30**
14. High degree of generation	Does the activity involve a high degree of generation?	0	1	**29**
Retention				
15. Retention	Does the activity provide opportunities to successfully link form and meaning?	**28**	**29**	**30**

16. Exemplification	Does the activity promote exemplification?	1	**30**	**30**
17. Mental image of the concept	Does the activity promote a mental image of the concept?	**30**	1	**30**
18. Avoiding interference	Does the activity avoid interference or confussion between words?	0	0	**30**

In the first month when using Canva, majority of participants distinguished 8 out of 18 components of the TFA model: one component for the motivation dimension (motivation towards learning), one component for notoriety (awareness of learning new lexicon) with the generation of the outline of its narrative, four for recovery (recovery, productive recovery, remembering, spaced recovery), and two of retention (form-meaning union and mental image of the concept) with recreational activities, use of graphic organizers and writing the narrative. For the generation dimension with the Canva application, they did not identify any of its three components.

During the second month, while working with the Makebeliefscomix application, students pointed out 11 of the 18 components of the TFA model. In each dimension, they observed the lack of one or two components. Considering the motivation category, the clarity of the lexical learning objectives and motivation towards learning through construction activities in the comic stood out. For noticing, they consider attention to keywords and awareness of the new lexicon in the comic construction. In the recovery component, the evocation and form-meaning union through associated images with meanings stood out, as well as productive and spaced recoveries. Finally, through reading instructions aloud, they perceived the receptive generative use of the word and exemplification.

In the third month with Pixton, participants recognized the development of the 18 components of the 5-dimensional TFA model in the task. With the activity of using or reusing the keyword, they identified lexical learning objectives, a motivation towards learning, and an appropriate selection of words. In the dimension of noticing, the reading activity with marking allowed them to highlight the attention to the keywords, become aware of learning new lexis, and manage negotiation. The mental-lexical image activity helped them perform the productive, multiple, and spaced retrieval tasks. In the case of the generation component, reading aloud detonated productive generation and a high degree of generation through creativity and appropriate use of words. Finally, the mental-lexical image task promoted retention by stimulating the form-meaning union, exemplification, and mental concept image, avoiding interference.

At the end of the four weeks of working with each application, receptive and productive acquisition tests were administered to identify the average lexical knowledge of participants' target words after the treatment.

Table 4
Results of the Receptive Acquisition Test

	Sum of grades	Average	Variance	TFA elements
Canva	243	8.10	0.67	8
Makebeliefscomix	262	8.73	0.76	11
Pixton	283	9.43	0.58	18

Pixton reflects the highest average in receptive acquisition (Table 4) and less variability in ratings (Table 3). These data indicate that the majority of students have a consistent and positive opinion about the application to learn vocabulary. Besides, Makebeliefscomix has a high average but presents dispersion in the grades, so the students' perceptions vary. Finally, Canva shows the lowest average and an intermediate variance. Then, students evaluated it more uniformly but less favorably than the other applications.

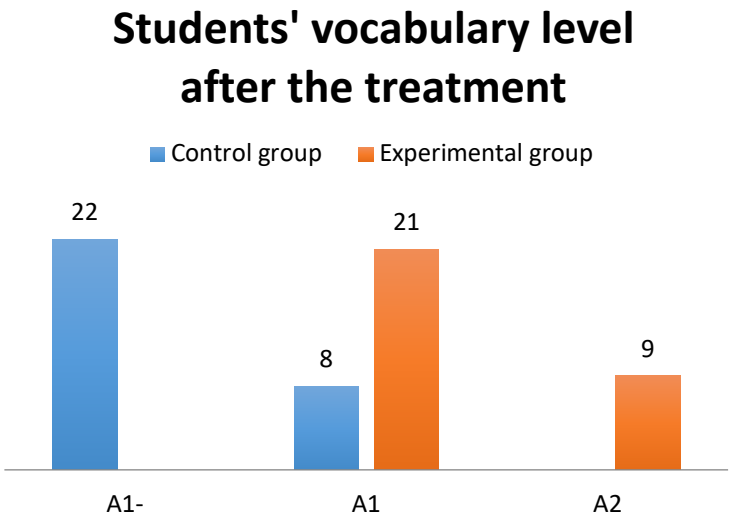
Table 5
Results of the Productive Acquisition Test

	Sum of grades	Average	Variance
Canva	242	8.07	0.26
Makebeliefscomix	261	8.70	0.22
Pixton	281	9.37	0.18

Pixton recorded the highest average along with the lowest variance in the productive aquisition test, making it the best-evaluated tool, with strong consensus for user satisfaction. Makebeliefscomix has a lower average than Pixton and a lower variance than Canva, however, satisfaction with this tool is more consistent despite the lower average. Last but not the least, Canva reports the lowest average but high variance, which means that opinions about this tool are discrepant.

Post-Treatment

Figure 2
Results of the Post-Diagnostic Stage



With a radical change in experimental group and minimal change in control group, the results highlight the relevance of implementing e-comics to develop lexical competence. Post-treatment, 21 students are at level A1, and nine students at A2. In contrast, only four more students from the control group reached level A2 compared to the pre-treatment stage, where eight students were at this level and 22 at level A1-. This phase demonstrates a positive association between e-comics and LC, asserting that digital co mics with three applications influence the development of students' lexical competence.

Discussion

The findings suggest that the use of e-comics as a pedagogical tool promotes lexical competence in English as a foreign language, which was achieved from ludic, creative, and dynamic activities based on the components of the TFA, exposing the student to keywords within dialogues and texts for subsequent recovery and use, improving the acquisition of new vocabulary. These indicators coincide with the studies by Hidalgo (2020), Breda (2021), Aristu & Torres (2021), and Verano & Carrillo (2023).

In the process of using Canva to create the first e-comic, the individual recreational activities proved to be plausible for lexical learning due to the activation of 8 TFA components such as motivation towards learning from the tasks, awareness of learning new vocabulary, recovery, productive and spaced recoveries, memory retrievals, form-meaning union and mental image of the concept. The findings indicate that the presentation and retrieval of target words through exercises such as word searches, crossword puzzles, and e-comics facilitated the memorization and learning of target words. This data matches Mayer's (2017) assertion that learning based

on interactive activities significantly improves information retention by involving students in active and continuous learning.

Furthermore, the development of collaborative graphic organizers with Canva allowed the categorization of ideas and spaced retrievals, techniques that enabled the visual organization of information, contributing to the connection between form and meaning, especially when they integrated their dialogues into digital narratives in the e-comic template. This supports Johnson & Johnson's (2019) assertion that collaborative learning leads to deeper and more retentive understanding. Finally, individual narratives using dialogues and clipart images in Canva favored productive recovery and recognition of the mental image, a process that reinforces the learned vocabulary, stimulating creativity and metacognitive awareness. In this way, visual applications and techniques enhance retention and understanding by creating a dynamic environment.

When creating the second e-comic with the application of Makebeliesfscomix, the 11 components identified by students for each dimension were: in the motivation dimension, clarity of the objectives of lexical learning and motivation towards learning generated by construction of the e-comics, seen as a unique experience to learn vocabulary that goes beyond memorization. As it was based on a design already established by the application itself, it promoted a didactic sequence guided through the construction of dialogues, scenes, and narratives in their e-comics. This coincides with the study by Sanhueza (2018), which alludes to the idea that narrative activities promote the generation process that deals with the reconceptualization processing. Thus, it consists of generating or creatively using the vocabulary acquired in a different context within e-comics.

In the noticing dimension, the results showed that with this application, students focused their attention on word marking and becoming aware of the new lexicon, which led them to focus on the target word connotation, being aware of their lexical growth and learning. Similarly, Gohar et al. (2018) and Sánchez et al. (2019) also found that input in the comic helps highlight and capture students' curiosity towards a target word, improving lexical memory.

In the recovery dimension, productive and spaced recovery was highlighted and remembered due to image-meaning association, making students creative and facilitating the assimilation of the new lexicon. This is in line with studies by Palacios & Plazas (2019) and Morales (2021), who mention that comic illustrations generate emotions, positively influencing the student's attitude toward learning and stimulating their imagination, facilitating conceptual assimilation due to the visual-lexical association process in multiple scenarios. Besides, images helped generate a playful environment that favors understanding the communicative situation, as Marin's (2022) study shows.

Considering retention, form-meaning union, and exemplification were identified with the practice of writing the e-comic sentences taking into account the contextualization and correct use of the words in combination and sentence construction activities as mentioned by Olagbaju & Popoola (2020) in their study. Finally, in the generation dimension, receptive generative use

was achieved by reading instructions aloud and writing their e-comics, stimulating their creativity, and increasing lexicon, coinciding with Jiménez's work (2023).

Regarding the third e-comic design with the Pixton application, the students developed the most vocabulary acquisition according to the receptive and productive tests and a post-treatment test. This is because of the activation of the 18 components of the dimensions from the TFA model thanks to the ludic, dynamic, and creative activities. Students perceived the motivation of lexical learning through experimenting with activities that focused on the clarity of the lexical learning objective and an appropriate selection of words. Findings by Caiza (2023) and Jiménez (2023) similarly affirm that activities using target words in sentence replacement favor retention.

In noticing, students could highlight attention to keywords, be aware of learning the new lexicon, and manage negotiation of meanings with activities such as reading and marking the words within their productions. Olagbaju & Popoola (2020) and Tovar & Pineda (2021) have also demonstrated that target-word noticing in narrative texts allows students to become aware of vocabulary use, developing lexical competence. Furthermore, mental-lexical image activity, sentence combination and construction, gap filling, and image-to-lexical association in Pixton performed productive, multiple, and spaced retrieval tasks, similar to Chinga & Pérez's study (2023), where sentence creation allows students to understand the use of keyword in different writing situations.

In the case of the retention dimension, four elements are present for the treatement group: the form-meaning union, exemplification, mental image of the concept, and interference avoided, thanks to the mental-lexical image task that took place at the same time when the students designed the characters, settings, and images they used in their e-comics. This confirms the findings by Alcaraz-Mármol (2021) and Hidalgo (2020) that the mental image of the word stimulates creativity in writing dialogues in a comic strip and avoids word confusion.

Finally, in the generation dimension, the students focused on writing their e-comic and reading it aloud to develop a productive and high-grade generation that evidenced creativity and appropriate use of words. Similar studies by Sanhueza (2018), Sánchez et al. (2019), and Nadal & Thome (2021) affirm that the implementation of reading aloud as a generative activity promotes clarity of meaning of words, expanding lexical knowledge.

It follows that using the e-comic strip based on intentional activities is more conducive to improving vocabulary learning in English, primarily promoting the retrieval, creation, and extension of the lexicon. Moreover, the results show that the e-comic strip stimulates students' creativity through visual, sensory, and graphic elements that capture their attention, promote active participation, and increase L2 literacy. To achieve this, the teacher selects specific lexical content and segments the comic strip's themes into semantic fields that categorize the words for easy assimilation (Caiza, 2023). In linguistic terms, the comic strip emphasizes deducing lexical meaning through its illustrations and situational content. In summary, the e-

comic strip offers a new, easily readable experience with simple and accessible syntax, creating enriching experiences with varied linguistic and lexical content.

It is worth mentioning that previous studies have focused on activities using physical materials and are conducted in face-to-face settings (Hu & Nassaji, 2016; Zou & Xie, 2018 and Nakata & Webb, 2016). The contribution of this study lies in its analysis of the development of lexical competence through technology-mediated activities in a virtual environment.

Recommendations

The didactic applications of e-comics go beyond simple language exposure making it a favorable means for learning vocabulary in a foreign language. However, it is worth noting that one of the main limitations of this research is the sample size, as it only works with English language learning. There is also variation in the participants' performance with each app, prompting reflection on the possibility of considering the specific characteristics of the applications used in activities. Thus, exposing students to different resources may lead to enriched data to interpret individual perceptions (Hidalgo, 2020). Secondly, before replicating the research in favor of innovating teaching practices in hybrid or virtual environments, we suggest verifying that participants have access to the Internet and possess a device for work, as well as minimal digital skills to carry out their activities. Teachers need to design a techno-pedagogical model framed within an active methodology and aligned with their program, containing activities with explanatory tutorials and evaluation instruments. Finally, we recommend collecting qualitative data to complement quantitative findings for a more complete understanding of the phenomenon.

It is crucial to consider these limitations for future research and expose the same groups to different treatments. Thus, future research could explore the influence of grammatical categories and their relationships for vocabulary learning, implications of incidental vocabulary teaching mediated by technology, the articulation between writing and reading in L2 through comics, creativity in discursive areas, the digitalization of comic strips as a techno-pedagogical tool, the development of cultural and colloquial language in L2 through narrative comics, cultural analysis through idiomatic expressions in English, among others.

Conclusion

As a pedagogical resource for vocabulary learning in English, the comic strip has proven to be a creative medium to develop receptive and productive lexical skills. The activities developed around its application generated motivation, creativity, and student engagement in new learning. This process of interest contributed to the cognitive processing of reflective recall, reducing lexical forgetting. The characteristics of the comic strip, such as visibility, graphics, and color, generated confidence and enthusiasm for actively participating in constructive exercises. Likewise, these properties stimulated the student's memory through the form-meaning association of words, reinforcing lexical recall. Additionally, the search for word meanings encouraged participants to expand their tools and sources of information. They

utilized dialogue, negotiation, internal memory, and various means to diversify their resources, thus demonstrating a more active and committed approach to their learning.

At the same time, negotiation promoted the development of communicative skills in the language, significantly improving the student's oral and written expression. Regarding form retrieval, it was also observed that using definitions or derivations mitigated confusion or guessing of word connotations. The tasks of filling in gaps, creating sentences, and writing a comic strip did not merely involve using notable words but also activated the cognitive base for lexical learning through decontextualization exercises. These activities stimulated the need for appropriate use of the learned words, which in the long term led to their satisfactory application in different communicative contexts. Similarly, enhanced analysis and synthesis skills offered by ICTs, created innovative spaces for activities and fostering creativity in task design. The digitalization of exercises facilitated the development of technological competencies related to learning English vocabulary.

Finally, it is essential to highlight that our hypothesis was confirmed, demonstrating that the e-comic strips as a pedagogical tool supported by technological mediation (using applications like Canva, Makebeliefscomix, and Pixton) with well-designed activities is effective for learning vocabulary and even developing reading and writing skills in an innovative and motivational way from the student's perspective; a model that addresses the needs and demands of today's educational modalities.

References

Alcaraz-Mármol, G. (2021). Aprendizaje De Vocabulario En Segunda Lengua En Educación Primaria: Poniendo A Prueba El Modelo Technique Feature Analysis. *RLA. Revista de lingüística teórica y aplicada*, *59*(2), 43–62. http://dx.doi.org/10.29393/rla59-10avga10010

Alejos, E. M. (2017). Competencia léxica, un pilar fundamental para los procesos de lectura y escritura universitaria. *Acción Pedagógica, 26*(1), 60–68.

Aristu, A., y Torres, L. (2021). El mapeado de textos: un recurso para el aprendizaje del léxico. Marco ELE. Revista de Didáctica Español Lengua Extranjera, (33).

Barón, L., Müller, O., y Labos, E. (2013). Los conceptos innatos en la obra de Chomsky: Definición y propuesta de un método empírico para su estudio. *Avances en Psicología Latinoamericana, 31*(2), 324–343.

Beghadid, H. (2022). La enseñanza del vocabulario: Hacia una competencia léxica. *Hispanical, 1*(1), 25–33.

Berthely, J. C., Esquivel, I., y Aguirre, G. (2023). Recursos multimedia para el aprendizaje autónomo de vocabulario del inglés como lengua extranjera: Multimedia resources for autonomous learning of English vocabulary as a foreign language. *Estudios λambda. Teoría y práctica de la didáctica en lengua y literatura., 8*(2). https://doi.org/10.36799/el.v8i2.126

Borromeo, C. A., Fernández, J. A., y Ramírez, A. R. (2018). La tecnología en la enseñanza de idiomas: Evolución a través de los métodos. *REencuentro. Análisis de Problemas Universitarios, 29*(76), 133–154.

Breda, D. (2021). ¿Las actividades en las lecturas graduadas promueven el aprendizaje de vocabulario? Un estudio de Technique Feature Analysis. *Revista Nebrija de Lingüística aplicada a la enseñanza de Lenguas*, *15*(30), 103-117. DOI: https://doi.org/10.26378/rnlael1530430

Cáceres, M. F., Ramos, M. J., Díaz, D. C., y Chamorro, Y. C. (2018). Vocabulario receptivo en estudiantes de preescolar en la comunidad de Talca, Chile. *Innovación Educativa, 18*(78), 193–208.

Caiza, J. (2022). *Comic como recurso digital para el fomento de la lectura en los estudiantes de 3ro de bachillerato técnico*. Tesis de Maestría, Universidad Tecnológica Indoamérica, Ecuador. http://repositorio.uti.edu.ec//handle/123456789/2750

Castillo, Y., Zumeta, E., y Rodríguez, N. (2022). La competencia léxica en la enseñanza del idioma inglés como Lengua Extranjera. (Ensayo). Roca. *Revista científico-educacional de la provincia Granma, 18*(1), 275–288.

Ccoa, M. del P., y Alvites, C. G. (2021). Herramientas Digitales para Entornos Educativos Virtuales. *Lex: Revista de la Facultad de Derecho y Ciencia Política de la Universidad Alas Peruanas, 19*(27), 315-330. https://dx.doi.org/10.21503/lex.v19i27.2265

Chinga, P. y Pérez, D. (2023). *El guion de cómic como estrategia para ampliar el vocabulario*. Bachelor's thesis, Universidad de Guayaquil. Facultad de Filosofía, Letras y Ciencias de la Educación. https://repositorio.ug.edu.ec/items/824b60be-5e6d-491f-b6c8-398e70d77ca5

Consejo de Europa. (2020). El volumen complementario del Marco Común Europeo de Referencia de las Lenguas, ahora en español. Recuperado 1 de enero de 2024, de https://www.educacionyfp.gob.es/mc/accion-exterior/mira-lo-que-hacemos/actualidad/mcer-presentacion.html

Cordero, M., y Mejía, M. A. (2021). El Comic como Recurso Didáctico para Fortalecer los Procesos de Comprensión Lectora [Tesis de pregrado, Universidad Santo Tomas]. https://repository.usta.edu.co/bitstream/handle/11634/38207/2021mariancorderomariamejia.pdf?sequence=1&isAllowed=y

Córdoba-Baldrich, H. Y., y Maturana, Y. (2022). El uso de la historieta como estrategia metodológica para fortalecer competencias comunicativas en el aprendizaje del inglés. *Revista Electrónica en Educación y Pedagogía, 6*(10), 167–182. https://doi.org/10.15658/rev.electron.educ.pedagog22.04061011

De la Maya, G., y López-Pérez, M. (2021). Hábitos lectores y competencia léxica de futuros profesores de inglés em Educación Primaria. *Educ. Form., 6*(1). https://doi.org/10.25053/redufor.v6i1.3504

Flantrmsky, O. G. (2022). Cómic y novela gráfica como literatura menor: Debates y validez como producto cultural. *Folios, 56*, 3–6. https://doi.org/10.17227/folios.56-13477

Flores-González, E. (2020). El proceso de aprendizaje de la asignatura de Biología en modalidad blended learning. Journal of Technical Education/Revista de Educación Técnica, 4(13).

Flores, E. (2023). El aprendizaje de la Biología en un entorno virtual: Learning biology in a virtual environment. *Journal of Behavior, Health & Social Issues*, *15*(1). https://doi.org/10.22201/fesi.20070780e.2023.15.1.83464

García-López, M. (2000). Estrategias de aprendizaje de vocabulario de inglés utilizadas por los estudiantes de Secundaria. *Lenguaje y textos, 15*, 61–70.

García, D. J., Delgado, A. A., González, E. A., y Swiggers, G. (2020). Estrategias y actividades para aprendizaje del léxico en dos manuales escolares de educación primaria. Horizontes. *Revista de Investigación en Ciencias de la Educación, 4(*13), 15-29. https://doi.org/10.33996/revistahorizontes.v4i13.88

Gohar, M., Rahmanian, M. y Soleimani, H. (2018). Technique Feature Analysis or Involvement Load Hypothesis: Estimating their predictive power in vocabulary learning. *Journal of Psycholinguistic Research*, *47*(4), 859–869. https://doi.org/10.1007/s10936-018-9568-5

Gómez, J. F., Díaz, C., y Gómez, W. D. (2021). Estrategias de aprendizaje y creencias sobre el idioma inglés: Una aproximación correlacional en estudiantes universitarios. *Práxis Educativa, 16*, 1-17. https://doi.org/10.5212/PraxEduc.v.16.16572.024

Guerrero, L. E., Pérez, M., Dajer, R., Villalobos, M., y Méndez, Y. (2022). Estrategias de Aprendizaje en inglés empleadas por estudiantes universitarios de Pedagogía de una universidad mexicana. *Ciencia y Educación, 6*(3), 35–51. https://doi.org/10.22206/cyed.2022.v6i3.pp35-51

Hernández-Sampieri, R. & Mendoza, C. P. (2018). Metodología de la investigación: las rutas cuantitativa, cualitativa y mixta. México: McGRAW-HILL. 774 Pp.

Hernández, J., Torres, D., y Camargo, E. (2020). Era digital en tiempos de pandemia: Educación, color, conocimiento y comunicación. *Utopía y Praxis Latinoamericana*, *25*(8), 216–230. https://doi.org/10.5281/zenodo.4087421

Hidalgo Gallardo, M. (2020). Efectos del método de presentación léxica en la recuperación y el reconocimiento del vocabulario en español LE/L2 para italófonos. *RILEX. Revista Sobre Investigaciones léxicas*, *3*(1), 47–73. https://doi.org/10.17561/rilex.3.1.5377

Hu, Ma., & Nassaji, H. (2016). Effective vocabulary learning tasks: Involvement Load Hypothesis versus Technique Feature Analysis. *System*, 56, 28–39.

Huerta, S. M., y Ortega, N. (2021). Incorporación de historietas en el aprendizaje del inglés básico en el Centro de Idiomas, Universidad Nacional Santiago Antúnez De Mayolo. *Llamkasun, 2*(4), 110–123. https://doi.org/10.47797/llamkasun.v2i4.67

Jiménez-Arriagada, V., Bañales-Faz, G., y Lobos-Sepúlveda, M. T. (2020). Investigaciones del cómic en el área de la didáctica de la lengua y la literatura en Hispanoamérica. *Revista mexicana de investigación educativa, 25*(85), 375–393.

Jiménez, I. (2023). Implementing the creation of comics using information and communication technologies to enhance reading and writing skills strengthening the autonomous learning of the 11-2 section at marco tulio salazar nocturnal high school during the second Quarter of. *Ciencia Latina Revista Científica Multidisciplinar*, *7*(1), 9294–9307. https://doi.org/10.37811/cl_rcm.v7i1.5050

Johnson, D. W., y Johnson, R. T. (2019). Cooperation and the Use of Technology. Cambridge University Press.

Marin-Marin, A., y Hernández-Romero, M. I. (2022). La competencia léxica en inglés de estudiantes universitarios en México. *Revista Lengua y Cultura, 4*(7), 15–25. DOI**:** https://doi.org/10.29057/lc.v4i7.8726

Marin, L. C. (2022). *Los cómics para mejorar la comprensión de textos en el área de inglés en estudiantes del VI ciclo de la IE "32075 de Tambogán", Churubamba-Huánuco 2020*. Tesis de Pregrado, Universidad de Huánuco, Perú. http://repositorio.udh.edu.pe/123456789/3232

Martínez, M. I. (2023). El mundo del comic: una propuesta didáctica para el aula de ELE. *redELE. Revista electrónica de didáctica del español lengua extranjera, 35*, 1-32.

Mayer, R. E. (2017). Multimedia Learning. Cambridge University Press.

Maza, A. E. (2012). Un acercamiento al cómic: Origen, desarrollo y potencialidades. *Perspectivas docentes, 50*, 12–16.

Morales, M. (2021). *Estrategia del uso del cómic y organizadores visuales para fortalecerla expresión escrita en el aprendizaje del idioma inglés desde la perspectiva de los estudiantes de nivel A2 de una universidad privada de Lima 2020-2.* Tesis de Maestría, Universidad de Perú, Perú. https://hdl.handle.net/20.500.12867/4929

Mosquera, D. M., y Rendón, Á. R. (2021). Dibujando para impulsar el desarrollo: Una historieta para compartir los aprendizajes del proyecto InnovAcción Cauca. *Signo y Pensamiento, XL(*79), 1–21. https://doi.org/10.11144/Javeriana.syp40-79.didh

Nadal, L., y Thome, S. (2021). Mediación y aprendizaje de lenguas en contextos de no inmersión: un análisis experimental. *RLA. Revista de lingüística teórica y aplicada*, *59*(2), 111–132. http://dx.doi.org/10.29393/rla59-13mals20013

Nakata, T., y Webb, S. (2016). Vocabulary learning exercises: Evaluating a selection of exercises commonly featured in language learning materials. En Tomlinson, Brian (ed.), *Second Language Acquisition Research and Materials Development for Language Learning*, Oxon, Inglaterra: Taylor and Francis, 123–138.

Nation, I. S. P., & Webb, S. A. (2011). Researching and Analyzing Vocabulary. Heinle, Cengage Learning.

Olagbaju, O.O. & Popoola, A.G. (2020). Effects of audio-visual social media resources supported instruction on learning outcomes in reading. *International Journal of Technology in Education (IJTE), 3*(2), 92–104. https://doi.org/10.46328/ijte.v3i2.26

Onieva-Palomar, R. (2019). El aprendizaje del español como lengua extranjera: La importancia de utilizar el diccionario adecuado. *Foro de Profesores de E/LE,* (15), 147-160. https://doi.org/10.7203/foroele.0.15598

Palacios, D., y Plazas, J. (2019). *Un cómic: una estrategia didáctica enmarcada en el enfoque CLIL en inglés para fortalecer el proceso de aprendizaje de conceptos propios de Science.* Tesis de Pregrado, Universidad Libre de Colombia. https://repository.unilibre.edu.co/handle/10901/18752

Pasuy, G. Y., y Agudelo, C. L. (2022). Competencia léxica y procesos de variación semántica en los verbos del parlache*. *Cuadernos de Lingüística Hispánica, 39*, 1–20. https://doi.org/10.19053/0121053x.n39.2022.13902

Pickel, A. (2018). La cultura como sistema semiótico: Una redefinición de la idea de cultura desde la perspectiva sistemista. *Cultura y representaciones sociales, 13*(25), 9–47. https://doi.org/10.28965/2018-25-01

Robles, P. (2018). Competencia léxica y oportunidades de aprendizaje léxico en el aula de lenguas: Una aproximación teórica. *Lengua y Habla, 23*, 157–182.

Rodríguez-Montes, T. (2020). El desarrollo de la competencia léxico-semántica a través de la morfología léxica. *Revista de Filología de la Universidad de La Laguna, 40*, 275–288. https://doi.org/10.25145/j.refiull.2020.40.13

Roselló, J. (2021). Metodología sociolingüística y enseñanza de ELE. marcoELE. *Revista de Didáctica Español Lengua Extranjera, 33*.

Salinas, M. A. (2022). El cómic como herramienta para la enseñanza y la transmisión del patrimonio. Argonautas. *Revista de Educación y Ciencias Sociales, 12*(19).

Sánchez, C., Pérez, M., y Robles, P. (2019). The effects of word frequency and typographical enhancement on incidental vocabulary learning in reading. *Journal of Spanish Language Teaching, 6*(1), 14–31. https://doi.org/10.1080/23247797.2019.1590000

Sanhueza , C. H. (2018). *Desarrollo de la competencia léxica en aprendientes de inglés como lengua extranjera de nivel intermedio*. Tesis de Doctorado, Universidad de Concepción, Chile. http://repositorio.udec.cl/bitstream/11594/3000/4/Tesis_Desarrollo_de_la_competencia_lexica.Image.Marked.pdf

Sanhueza, C., Ferreira, A., & Sáez, K. (2018). Desarrollo de la competencia léxica a través de estrategias de aprendizaje de vocabulario en aprendientes de inglés como lengua extranjera. *Lexis, 42*(2), 273–326. https://doi.org/10.18800/lexis.201802.002

Soto-Cano, A. B. (2019). El uso del cómic en el aula de Francés como Lengua Extranjera (FLE). *Citius Altius Fortius, 34,* 139. https://doi.org/10.15366/tp2019.34.011

Torres, L., y Aristu, A. (2021). La dimensión personal en el aprendizaje del léxico en la red. MarcoELE. *Revista de Didáctica Español Lengua Extranjera, 32*.

Tovar, V., y Pineda, D. (2021). *El cómic: una estrategia didáctica para el aprendizaje y fortalecimiento de vocabulario en inglés de los estudiantes del curso 203 de un colegio privado*. Tesis de Pregrado, Universidad Libre de Colombia. https://repository.unilibre.edu.co/handle/10901/19440

Trujillo, F., Salvadores, C., y Gabarrón, Á. G. (2019). Tecnología para la enseñanza y el aprendizaje de lenguas extranjeras: Revisión de la literatura. *RIED-Revista Iberoamericana de Educación a Distancia, 22*(1), 153–169. https://doi.org/10.5944/ried.22.1.22257

Valdés-León, G. (2021). Competencia léxica y escritura académica: Analíticas de aprendizaje en un curso de escritura universitaria. *Texto Livre: Linguagem e Tecnologia, 14(*1). https://doi.org/10.35699/1983-3652.2021.24560

Vargas-Murillo, G. (2020). Estrategias educativas y tecnología digital en el proceso enseñanza aprendizaje. *Cuadernos Hospital de Clínicas, 61*(1), 114–129.

Verano, V. y Carrillo, J. (2023). *Estrategia pedagógica basada en la elaboración de un Cómic Digital para la enseñanza del léxico en Inglés aplicado a los estudiantes de grado sexto de la Institución Educativa Juan Pablo I de Cúcuta.* Tesis de Maestría, Universidad de Cartagena, Colombia. https://repositorio.unicartagena.edu.co/bitstream/handle/11227/16720/TGFVictor%20Verano_Judith%20Carrillo.pdf?sequence=1&isAllowed=y

Vilches-Fuentes, G. (2019). El cómic: ¿un arte secuencial?: Una crítica al concepto de secuencia y la clasificación de las transiciones entre viñetas de Scott McCloud. *Neuróptica: Estudios sobre el cómic, 1*, 203–217. https://doi.org/10.26754/ojs_neuroptica/neuroptica.201914328

Zambrano, H. J., y García, M. A. (2022). El desarrollo lector en el nivel léxico de los estudiantes del nivel de básica superior. *Dominio de las Ciencias, 8*(3), 92.

Zou, D., & Xie, H. (2018). Personalized word-learning based on Technique Feature Analysis and learning analytics. *Journal of Educational Technology y Society*, 21, 233–244

Corresponding author: Norma Flores-González
E-mail: norma-fg@hotmail.com

Reviewers: Volume 13 – Issue 3

The editorial team would like to thank the following reviewers for their contributions to the peer review for this issue of the journal. Their dedication and assistance are greatly appreciated.

Senior Reviewers

Dr Murielle El Hajj Nahas
Lusail University, Qatar
Email: murielle.elhajj@hotmail.com

Dr Mikel Garant
Beijing Institute of Technology, China
Email: mikel.garant@helsinki.fi

Dr Urarat Parnrod
Songkhla Rajabhat University, Thailand
Email: urarat.parnrod@gmail.com

Dr Shwadin Sharma
California State University Monterey Bay, USA
Email: ssharma@csumb.edu

Reviewers

Dr Rena Alasgarova
Baku Oxford School, Azerbaijan
Email: rena.alasgarova@mtk.edu.az

Dr Philip Ajewole
Federal University Oye-Ekiti, Nigeria
Email: philip.ajewole@fuoye.edu.ng

Dr Azlan Abdul Aziz
Universiti Teknologi MARA Melaka, Malaysia
Email: azlan225@uitm.edu.my

Dr Shiao-Wei Chu
National Pingtung University, Taiwan
Email: shiaowei0819@gmail.com

Dr Alice Gasparini
University for Foreigners of Siena, Italy
Email: alice.gasparini@unistrasi.it

the iafor
journal of education

ISSN: 2187-0594