An Investigation into the Impact of ICT Applications on Improving Human's Cognitive Skills – Implication for Language Teaching

Huynh Ngoc Mai Kha[1*]

[1] University of Foreign Language Studies, The University of Da Nang, Vietnam

[*]Corresponding author's email: hnmkha@ufl.udn.vn

[*] https://orcid.org/0000-0002-6887-7613

https://doi.org/10.54855/paic.23411

ABSTRACT

Keywords: ICT application, cognitive skills, language learning, online learning

The purpose of this study is to investigate the impact of ICT application on the acquisition of cognitive skills of language learners. A questionnaire designed by Barnard et al. (2009) has been adopted to collect responses from participants in a teacher training program conducted by the University of Foreign Languages Studies, The UD. The research results demonstrate a positive tendency in language learners to acquire cognitive skills such as academic self-efficacy, time planning and management, study regulation, task strategies, and metacognitive activities when exposed to the online learning environment. This also suggests implications for language instructors to take into consideration to improve learning outcomes.

Introduction

In the era of information technology explosion, digital educational technology has the potential to significantly impact student development, the educational system, and teaching methods (Cao, 2022), (Hoang, Duong & Le, 2023). The use of digital educational technology includes collaboration between humans and machines, integration across borders, and collective creation. With the recent increase in the use of online technology in classrooms, there have been a variety of choices in the mode of delivery, from online to a blended mix of face-to-face and Learning Management Systems (Rasheed et al., 2020). In addition, the outbreak of the Covid-19 pandemic has created a new era of remote learning and teaching. With the aid of online technology, students are believed to be familiar with this type of interaction (Hodges et al., 2020). As a consequence, it is recognized that the opportunities for interaction have decreased due to the flexibility of online learning in terms of anywhere and anytime learning, which leads to the fact that students have to learn to decide the time and way of engaging with learning activities (Broadbent et al., 2022).

Recently, numerous studies have suggested the significance of technology in education and its benefits in fostering the improvement in students' learning outcomes, including promoting cognitive insights and enhancing advanced thinking abilities. Nevertheless, we can perceive different opinions on the impact of online technology on students' cognitive abilities. It is

believed by some authors that some researchers blamed the continuous multitasking in online learning for the impairment in students' cognitive abilities, while others recorded the outweighing benefits over the challenges in online learning. From that perspective, it is noted that there should be more research on this topic so as to provide comprehensive insights into the correlation between learning effectiveness and technology application.

From that context, this study aims to explore the impact of digital applications on language learners' cognitive skills development. Specifically, the study will investigate the use of digital applications in a training course for English language teachers in the central region of Vietnam. It will examine how these applications influence the learners' academic self-efficacy, time planning and management, study regulation, task strategies, and metacognitive activities.

Literature review

So far, there has been a variety of research on the use of technology in education in general and in language education in specific. Klimova (2023) has conducted a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology to identify and analyze relevant research articles and found that cognitive gains are believed to be more effective when working with printed texts as learners are frequently exposed to more senses through digital language education. This was confirmed by another study by Klimova and Kacetl (2017), who announced the high ability of vocabulary acquisition, more engagement opportunities, and students' inclusion in communication in computer games. Similarly, Peterson et al. (2020) recognized the enhancement in collaboration and language output, especially vocabulary, under the use of digital games in language learning.

What's more, with the outbreak of the Covid-19 pandemic, multiple studies have been conducted on the situation of education delivery in the pandemic context. As a consequence, the positive effects of online learning were recorded by many researchers, including El Mustapha Hayat et al. (2023), who noted the remarkable improvement in teachers' perceptions of continuous learning and learning readiness. With the awareness of the increasing popularity of ICT in education, Thomas & Ambrose (2020) have explored the impact of ICT use patterns on postgraduate students' academic achievement in developing countries and suggested that there is a remarkable correlation between the learners' performance and the blending of ICT use in teaching and learning. Firdaus & Rahayu (2019) described the effect of STEM-based learning on cognitive skills improvement. The research proposed feasible differences in learning outcomes between experimental groups and put forward a conclusion that learners' cognitive skills could be improved under exposure to STEM-based learning. Drigas and Karyotaki (2014) has conducted a study to make a revision on the use of internet supported learning tools and its influence on learners' cognitive skills including critical thinking, problem-solving, independent inquiry, creativity, communication, collaboration, and digital literacy.

Theoretical Framework

ICT Application

According to Sayaf et al. (2022), digital education technology is depicted by the utilization of suitable ICT applications and teaching pedagogy to aid the learners' development of cognitive skills and other abilities. The main components of digital education technology include digital learning skills, usability and usefulness of digital tools, and Internet-based skills. Tondeur et al. (2008) emphasized three essential pedagogical applications of computer-based learning: operational technology, information tools, and learning tools.

Cognitive skills

There are various perceptions about cognitive skills among researchers from cognitive theories and earlier. While recent studies look at cognitive skills as a holistic capability with developmental change, earlier theories alternatively linked acquired piecemeal information packets with cognitive skills. From the lens of cognitive theories, Firdaus & Rahayu (2019) first defined cognitive skills as an "integrated mixture of specific facts and procedures for utilizing those facts." In other words, cognitive skills are made up of both declarative and procedural knowledge, secondly as acquired abilities through training and/or experience, in contrast to intellectual abilities such as intelligence, which is supposedly resistant to change via training, and thirdly as applicable skills in the domain of activity, but their use is generally confined to that domain. Finally, cognitive skills go through several ordered stages while being acquired. To be more specific, Hunter (1986) stated that cognitive ability is the "ability of the human brain to extract, process, store, convey, and reproduce information from the objective world". Cognitive ability usually consists of verbal ability, numerical ability, technological ability, logical reasoning skills, and so on. With a more specific view, Hunter (2013) viewed cognitive skills as "how a student thinks, solves problems and learns, gives a larger impact on his ability to play a role in a society that is rich with technology, compared to his knowledge about hardware or certain software".

When discussing the relation between cognitive skills and self–regulated learning, Zimmerman (2002) stated that self-regulated learning refers to the autonomous process by which individuals convert their cognitive and physical capabilities into skills specific to a task. This learning approach includes metacognitive, motivational, and behavioral aspects, all self-initiated for skill and knowledge acquisition. It involves practices like setting objectives, strategizing, employing self-reinforcement, maintaining self-records, and guiding oneself through self-instruction. Learners manage their educational progress through hidden cognitive methods and explicit behavioral actions, such as choosing, adapting, or creating beneficial personal surroundings or pursuing social assistance. In this research, the author approached the study of cognitive skills in language learning by examining how learners organize and allocate their study time, select strategies for accomplishing learning tasks, manage their studies, optimize their academic outcomes, and engage in metacognitive activities. These activities are identified as elements of self-regulated learning within the context of this research.

Research Questions

To fulfill the purpose of the study, the survey was seeking to answer the following research questions:

1. Does ICT application in teachers' training courses conducted by UFLS, The UD contribute to the improvement in learners' academic self-efficacy, time planning and management, study regulation, task strategies, and metacognitive activities?

2. What are the implications for language teaching in an online learning environment?

Methods

The study employed a mixed-method approach, including questionnaires, interviews, and classroom observations. Survey data will be collected from 127 English teachers currently participating in a training course organized by the University of Foreign Language Studies, the University of Danang (UFLS, The UD), and the National Project of Foreign Languages in central Vietnam. In addition, the researcher conducted individual and focus group interviews with a randomly selected group of 10 teachers to gather diverse opinions on the use of digital applications in their courses. Classroom observations also played a significant role in understanding how these digital applications are utilized and how learners perform in a digital learning environment.

Regarding questionnaires, the study used the online SRL measure, the Online Self-regulated Learning Questionnaire, which was developed by Barnard et al. (2009). The Self-Regulation for Learning Online (SRL-O) questionnaire was designed to measure learners' learning motivations and strategies in an online environment. Its structure covers 10 factors, including (1) online self-efficacy, (2) online intrinsic motivation, (3) online extrinsic motivation, (4) online negative achievement emotion, (5) planning and time management, (6) metacognition, (7) study environment, (8) online effort regulation, (9) online social support, and (10) online task strategies. However, for the sake of the study, we only made use of items that belong to categories of learners' academic self-efficacy, time planning and management, study regulation, task strategies, and metacognitive activities. The questionnaires used a Likert scale from 1 to 7, ranging from not true at all to very true of me.

The study implemented a summer training program designed for 127 English teachers residing in the provinces of Dak Lak, Phu Yen, and Dak Nong from July to September 2023. This training initiative was organized as a network-oriented endeavor with the primary objective of enhancing the professional development of educators in the field. The course includes topics of English for Teaching, Testing and Assessment, Building Learning Environments, and Information and Communication Technology (ICT) integration. Under the guidance of the National Foreign Languages Project, the program adopted a blended mode of instruction, combining face-to-face interactions with online delivery methods. Throughout a two-month training course, participants were invited to complete questionnaires based on the framework presented by Barnard et al. (2009). These instruments aimed to investigate the impact of technology on various aspects of their cognitive skills, including academic self-efficacy, planning and time management, study regulation, task strategies, and metacognitive activities.

Findings and discussion

Table 1.

Description of parameters

|	(A) Online Academic Self-efficacy	(E) Planning and time management	(G) Online Effort Regulation	(I) Task Strategies	(J) Metacognition
COUNT	127	127	127	127	127
MEAN	5.154	5.013	5.035	5.132	5.173
STD	1.030	1.153	1.042	1.107	0.992
MIN	1.250	1.000	1.000	1.000	1.000
MAX	7.000	7.000	7.000	7.000	7.000

From the results, it is remarkable that learners tend to have high cognitive skills, manifested by values exceeding 5 across all categories. Upon closer examination, it is evident that metacognitive activities have the highest mean score at 5.173. This implies that participants demonstrated a heightened capacity for self-reflection on their learning strategies when faced with similar academic tasks. Additionally, they exhibited an ability to allocate adequate time to ensure proper academic undertakings. The high level of cognition is also depicted through their awareness of self-assessment in their learning, which means that they normally look over past feedback they received in the past and see how they have improved in current learning based on the criteria regulated by the trainer.

Likewise, participants are apt to manage their academic self-efficacy, as evidenced by a mean score of 5.154. This suggests that they are confident in achieving high academic achievement within the online learning environment and through the utilization of digital tools. They are acquainted with online platforms when interacting, obtaining content, and completing tasks, in alignment with the instructions of their instructors. Accordingly, it is predictable that the mean value of task strategies is also in the high range of 5.132, proving that learners can apply their cognitive skills to accomplish the tasks in the course. They are comfortable generating summaries, drawing connections between course content, and formulating their ideas within the context of their learning.

What's more, the quantitative data also affirm that participants are efficient in planning their study, managing time, and regulating online learning. They reported that they often establish realistic deadlines to achieve their learning objectives, break larger goals into smaller measurable goals, and make a list of things to do for their learning plan. Also, as participants are adults who have the motivation for any activities in their lives, they are consistent with their learning goals and try their best to overcome obstacles to pull themselves back to the learning goals.

Figure 1.

Correlations between categories
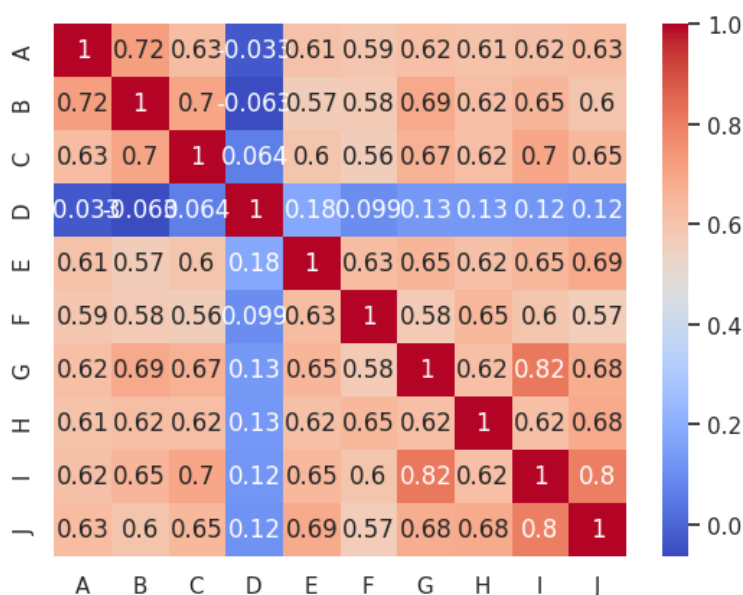
Besides, the data also reveals interesting stories about the correlations between the categories. In terms of positive correlation, the data said that online effort regulation has a strong positive correlation with task strategies with a correlation indicator of 0.82 (Table 2). Similarly, 0.8 is the value that states a positive correlation between task strategies and metacognition. This means that if learners have a strong ability to regulate their online effort, they are found to be advantageous in identifying and taking task strategies in their learning and vice versa. This shares the same tendency when looking at the correlation between task strategies and the metacognition of learners. Interestingly, the figures in Table 2 show that all categories (A, E, G, I, and J) have a strong positive correlation with any of the rest in the lists. The correlation value between categories can be summarized as follows: A – E (0.61), A – G (0.62), A – I (0.62), A – J (0.63), G – E (0.65), E – I (0.65), E – J (0.69).

The findings of the research discussed above have indicated that technology has a positive impact on the development of learners' cognitive skills. From this perspective, this study put forward some suggestions for language teaching:

First, instructors should take advantage of digital technology to create an effective learning environment that supports the accessibility of learners from far locations. Also, there should be awareness among instructors that a digital technology-based learning environment would benefit learners from the perspectives of learning outcomes, learning conditions, and cognitive skills development. Second, it is suggested that instructors should have a profound understanding of their learners to adopt suitable specific training strategies. Factors like learners' needs and proficiency are advisable for instructors to look at when deciding on a methodology in a digital context. Thirdly, various techniques should be applied when teaching to expose learners to the engagement of several senses while learning and then effectively contribute to the development of potential cognitive skills related to the use of technologies.

Finally, instructors should provide frequent feedback to learners to help them maintain their motivation. In order to do so, instructors should take time to equip themselves with digital pedagogy such as attending workshops, seeking consulting from experts, peer learning…

The observations and interviews were conducted as part of this study to elicit rich, detailed information about participants' cognitive strategies and learning behaviors. Moreover, these two techniques are said to provide deep insights into learner's approaches, particularly in an online context where direct observation of learning behaviors might be more challenging. It is proved that there is a consensus between the quantitative results acquired through questionnaires and the results obtained by observation and interview. Many teachers who were invited to share their perceptions about self-reflection and metacognition expressed their awareness in conducting activities (keeping online diaries and online reflective journals…) as proofs of their self-assessment process and adjustments in their learning approaches (such as actively sharing opinions in the discussion, posting online queries on the forum to get peer support…). There were a variety of ways that teachers adopted self-evaluation during the course. Some summarized what they learned in diaries and e-portfolios, and some kept discussing their doings with colleagues in the course. Moreover, observing how the teacher managed their time during the course, the author recognized that teachers tended to complete online assignments and similar times of the day, which meant they scheduled the same time for an activity in the course. As for task strategies, teachers illustrated various techniques to acquire the best learning outcome. Many shared that they spent much of their time reading advanced materials about the topics before class. Some read all the online posts and searched for extra materials to gain in-depth knowledge. Some others had the inclination to ask questions for clarification.

Conclusion

In the context of the Covid-19 pandemic, there has been a shift from face-to-face learning to online learning or blended learning with the aid of digital technology. This has brought about an emerging landscape in teaching and learning in the world. The impact of technology on education has been explored recently by a variety of studies. Some have profiled the positive role of technology in improving learning outcomes and 21st-century skills of learners. In the scope of this study, we have adopted questionnaires by Barnard et al. (2009) to investigate the gain of cognitive skills in language learners, namely Online Academic Self-efficacy, Planning and Time Management, Online Effort Regulation, Task Strategies, and Metacognition. Consequently, the results have shown the positive impact of online technology on learners' acquisition of cognitive skills, which are manifested through 5 categories specifically. Implications for instructors have been put forward with an aim to build up better learning outcomes for learners in online learning environments.

References

Broadbent, J., Panadero, E., Lodge, J. M. & Tyszkiewicz, M. F. (2022). *The self-regulation for online learning questionnaire.* Metacognition and Learning. 18, 135-163.

Cao, T. X. L. (2022). *Language Teachers' Perception and Practice of Adopting Blended Learning to Adapt to the New Normal*. AsiaCALL Online Journal, 13(5), 29-45. https://doi.org/10.54855/acoj.221353

Drigas, A., & Karyotaki, M. (2014). Learning Tools and Applications for Cognitive Improvement. *International Journal of Engineering Pedagogy (iJEP)*, *4*(3), pp. 71–77. https://doi.org/10.3991/ijep.v4i3.3665

El Mustapha, B*, Hayat, E, Nadia, S, & Lynda, O. (2023). Teachers' sense of competence in terms of ICT use: the case of secondary school teachers. *Research in Learning Technology*, 31.

Firdaus, A. R., & Rahayu, G. D. (2019). Effect of STEM-based Learning on the Cognitive Skills Improvement. *Mimbar Sekolah Dasar,* 6(2), 198-207. doi:10.17509/mimbar-sd.v6i2.17562

Hunter, J.E. (1986). Cognitive ability, cognitive aptitudes, job knowledge, and job performance. *J. Vocat. Behav*. 29, 340–362.

Hoang, N. T., Duong, N. H., & Le, D. H. (2023).Exploring Chatbot AI in improving vocational students' English pronunciation. AsiaCALL Online Journal, 14(2), 140-155.DOI: https://doi.org/10.54855/acoj.231429

Hodges, C., Moore, M., Lockee, B., Trust, T. & Bond, A,. (2020). *The Difference Between Emergency Remote Teaching and Online Learning.* Educause. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

Klimova, B.; Pikhart, (2023). M. Cognitive Gain in Digital Foreign Language Learning. *Brain Sci*. 13, 1074. https://doi.org/10.3390/brainsci13071074

Klimova, B.; Kacetl, J. (2017). Efficacy of computer games on language learning. *TOJET,* 16, 19–26.

Mazalah, A., Aidah Abdul, K., Rosseni, D. & Intan Safinas, (2013). Assessing ICT Competencies among Postgraduate Students Based on the 21st Century ICT Competency Model. *Asian Social Science*. 9 (16).

Peterson, M.; White, J.; Mirzaei, M.S.; Wang, Q., (2020). *A review of research on the application of digital games in foreign language education. In New Technological Applications for Foreign and Second Language Learning and Teaching; Kruk, M., Peterson, M., Eds.; IGI*. Global: Hershey, PA, USA. 69–92.

Pozo, J.I.; Pérez Echeverria, M.P.; Cabellos, B.; Sanchez, D.L. (2021). Teaching and Learning in Times of COVID-19: Uses of Digital Technologies during School Lockdowns. *Front. Psychol*. 12, 1–13.

Rasheed, A.; Amirrudin, K. & Nor Aniza, A. (2020). *Challenges in the online component of blended learning: A systematic review.* Computers & Education. 144. https://doi.org/10.1016/j.compedu.2019.103701

Sayaf, A.M.; Alamri, M.M.; Alqahtani, M.A.; Alrahmi, W.M. (2022). Factors Influencing University Students' Adoption of Digital Learning Technology in Teaching and Learning. *Sustainability.* 14, 493.

Thomas M. van der Merwe & Ambrose A. Azeta. (2020). *Exploring the Impact of ICT Use Patterns on Postgraduate Student Academic Achievement in a Developing Country*, Conference Paper at: https://www.researchgate.net/publication/371168580

Tondeur, J., Hermans, R.; van Braak, J., Valcke, M. (2008). Exploring the link between teachers' educational belief profiles and different types of computer use in the classroom. *Comput. Hum. Behav*. 24, 2541–2553.

Zimmerman, B.J. (2001). *Self –regulated Learning*. International Encyclopedia of the Social & Behavioral Sciences. 13855-13859. https://doi.org/10.1016/B0-08-043076-7/02465-7

Biodata

Dr. Huynh Ngoc Mai Kha is working as a vice rector at the University of Foreign Language Studies, the University of Danang. She has 20 years of teaching experience at the university level. Currently, Dr. Mai Kha is teaching cognitive linguistics and professional development at the graduate level in Foreign Language Studies at the University of Danang, Vietnam.