

## **Investigating the Impact of Duolingo on Second Language Learning Achievement and Self-Regulated Learning among French as a Foreign Language Learners**

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### **Abstract**

Amidst the challenges and opportunities in post-COVID-19 language education, innovative approaches are essential to support cognitive development and well-being in learners. This study employs an explanatory sequential design to explore Duolingo's impact on second language (L2) learning achievement and self-regulated learning in French as a foreign language (FFL) students. 48 FFL college students from an Iranian university participated, divided into experimental (n=25) and control (n=23) groups. The control group received Duolingo content as PDFs throughout a university semester, while the experimental group utilized Duolingo as a supplementary tool outside the classroom. Data collection involved Duolingo for schools, a self-regulated learning questionnaire, and semi-structured interviews. Quantitative analysis revealed Duolingo's significant impact on language achievement and self-regulation, emphasizing its efficacy in teaching French to beginners. Qualitative findings showcased positive attitudes towards Duolingo, lauding its accessibility, gamified learning, social interaction, customization, and enhanced speaking practice. This research offers insights into leveraging technology, like Duolingo, for cognitive development, language proficiency, and self-regulated learning amid post-COVID-19 language learning challenges.

*Keywords:* Duolingo, second language learning, self-regulated learning, language achievement, French as a foreign language, post-COVID-19.

## **Introduction**

In the wake of the post-COVID-19 era, the landscape of education has undergone transformative changes, urging educators to explore innovative approaches that extend beyond traditional cognitive development paradigms (Zhao & Watterston, 2021). Amidst these challenges, technology has emerged as a powerful ally, presenting novel opportunities to enhance language education and learners' overall well-being (Chen, 2022; Liu et al., 2023). Digital technologies and mobile applications have emerged as promising platforms for language acquisition, offering learners convenient and interactive ways to develop their language skills (Azizi et al., 2022; Elaish et al., 2019; Fathi et al., 2023; González-Lloret, 2019; Lin & Warschauer, 2015; Shafiee Rad et al., 2022; Yang et al., 2021; Yu & Trainin, 2022).

One language learning application that has gained significant popularity and recognition is Duolingo. Duolingo has attracted a broad user base with its diverse language courses, including French (Kessler et al., 2023; Loewen et al., 2019). Duolingo's gamified approach sets it apart, incorporating engaging activities and interactive exercises that captivate learners (Munday, 2017; Rachels & Rockinson-Szapkiw, 2018). Duolingo's accessibility, cost-free nature, and user-friendly interface have made it a preferred choice for language learners, including those studying French as a foreign language (FFL) (Savvani, 2019; Vesselinov & Grego, 2012).

Despite growing research on Duolingo's effectiveness in language learning (Jiang et al., 2020; Kessler et al., 2023; Li & Bonk, 2023), several gaps remain. While existing studies primarily focus on quantitative measures of specific second language (L2) skills like vocabulary and grammar (Kessler et al., 2023; Li & O'Rourke, 2022; Teske, 2017), gaining a holistic understanding necessitates exploring both quantitative and qualitative aspects of the learning experience. This study seeks to bridge two critical gaps in Duolingo's current knowledge. Firstly, a mixed methods design goes beyond solely evaluating L2 skill development through quantitative data. It additionally incorporates qualitative data collected through semi-structured interviews to explore learners' experiences and perspectives using Duolingo. This approach provides valuable insights into the motivational, affective, and self-regulatory aspects of learning with Duolingo, often overlooked by quantitative studies alone.

Secondly, while past research has examined the effectiveness of Duolingo, there is a scarcity of studies investigating its impact specifically on foreign learners of French. This focus on French is relevant as it fills a gap in the existing literature and addresses the unique needs of learners acquiring French as a foreign language, often facing challenges distinct from those encountered in other popular language choices. This study also addresses this gap

by focusing on this population, aiming to contribute valuable data to inform pedagogical practices and resource recommendations in learning French as a foreign language. By bridging these gaps, this study aims to provide a comprehensive and nuanced analysis of Duolingo's effectiveness and experiential aspects as a language learning tool for foreign learners of French. This expanded understanding can significantly contribute to the evolving knowledge of mobile-assisted language learning and inform future research and pedagogical practices.

Therefore, this study aims to address the research gap by investigating the effects of Duolingo on both L2 learning achievement and self-regulated learning among FFL college students. Via examining quantitative and qualitative aspects, this research provides a comprehensive understanding of Duolingo's role in language learning and its potential for enhancing learners' self-regulated learning skills. By harnessing the potential of technology, specifically Duolingo, we aim to delve deeper into the multifaceted aspects of language learning during the post-COVID-19 era, shedding light on how such innovative tools can foster cognitive development, language proficiency, and self-regulated learning. Our research endeavors to contribute valuable insights into the dynamic interplay between technology, language learning, and well-being and offers a unique perspective on preparing learners to adapt and thrive in today's world's rapidly changing educational landscape. Including quantitative and qualitative measures will offer a more nuanced perspective on the effectiveness of Duolingo in improving language learning outcomes and promoting self-regulated learning skills. The findings will have practical implications for language educators, researchers, and developers, guiding them in maximizing the benefits of Duolingo and similar language learning applications to create effective and engaging language learning experiences. The following research questions guided this study:

1. To what extent does the use of Duolingo impact FFL college students' language learning achievement?
2. To what extent does the use of Duolingo influence FFL college students' self-regulated learning in the context of French language learning?
3. What are the attitudes and perspectives of FFL college students towards using Duolingo as a language learning tool?

## **Literature Review**

### **Theoretical Framework**

This study is grounded in Social Cognitive Theory (SCT), as proposed by Bandura (1986), providing a comprehensive framework for understanding human learning and behavior. SCT emphasizes that individuals learn through direct experiences and observation and modeling of others' behaviors, with learning outcomes influenced by personal, behavioral, and environmental factors.

In the context of language learning, SCT offers valuable insights into how individuals acquire new languages, develop language skills, and regulate their learning processes. One key construct within SCT is observational learning, which suggests that learners acquire new behaviors and skills by observing others and the outcomes of those behaviors (Devi et al., 2017). When applied to language learning with Duolingo, learners may observe and imitate the language structures, vocabulary, and learning strategies modeled within the app, enhancing their language proficiency (Fathi et al., 2024).

Additionally, SCT emphasizes the importance of self-efficacy, referring to an individual's belief in their ability to perform a task or achieve desired outcomes successfully (Williams & Williams, 2010). Positive experiences with Duolingo, such as receiving immediate feedback and making noticeable progress, can bolster learners' confidence in their language learning abilities, enhancing their self-efficacy and motivation.

Furthermore, SCT highlights reciprocal determinism, which suggests that personal, behavioral, and environmental factors interact dynamically and reciprocally (Devi et al., 2017). In the context of this study, the interaction between learners' personal characteristics, their engagement with Duolingo, and the app's features collectively influence language learning outcomes and self-regulated learning processes.

By adopting SCT as the theoretical framework, this study aims to elucidate how Duolingo, a mobile language learning tool, influences second language learning achievement and self-regulated learning among French as a Foreign Language learners. SCT provides a lens to explore the complex interplay between individual cognition, behavior, and the learning environment, shedding light on the mechanisms underlying language learning processes in technologically-mediated contexts (Bandura, 1986).

### **Technology and Language Learning**

Technology integration has revolutionized various aspects of education, including language learning. Mobile-assisted language learning (MALL) has emerged as a prominent approach within this technological shift. MALL encompasses multiple elements such as continuous learning tools, easy access to data, adaptability to different learning behaviors, and flexibility in time and place (Duman et al., 2015; Pegrum, 2014; Liu et al., 2024; Reinders & Pegrum, 2016). Using mobile devices allows learners to learn language at their preferred location and time, reaping the benefits of mobile language learning (Liu et al., 2016; Pegrum, 2014).

The prevalence of mobile technology, particularly tablets and smartphones, has significantly impacted language learning practices, leading to substantial growth in MALL (Burston, 2015; Shadiev et al., 2017). Initially, mobile learning focused on content primarily designed by instructors and technologists. However, the landscape is evolving. Learners are

increasingly driven by their needs and preferences, leveraging technology to facilitate complex learning processes and enhance efficiency (Lai & Gu, 2011).

While technology's influence on formal language learning environments is well-established, its impact on informal, everyday learning remains a nuanced area of study (Lai, 2019). Despite this, technology can still benefit informal language learning, engaging learners outside the classroom and providing convenient access to learning resources (Lai & Gu, 2011).

The use of technology in language learning has been linked to increased engagement and constructive learning achievement (Lenkaitis, 2020). Learners' interest in utilizing technology for independent language learning is evident in the popularity and ubiquity of online language learning apps that offer diverse techniques and methods tailored to different learning styles (Thorne et al., 2009). With their attractiveness and portability, smartphones have become indispensable devices for users and language learners (Sung et al., 2016). The advancements in smartphone technology, both in terms of hardware complexity and software capabilities, have facilitated the use of various language-learning apps and games (Burston, 2014, 2015).

Within MALL, many language-learning apps are available on mobile devices. These apps include general-purpose platforms like Instagram and YouTube and dedicated language learning apps such as Duolingo, Babbel, Memrise, and Rosetta Stone. These apps have proven effective in supporting language learning (Duman et al., 2015; Loewen et al., 2019). Mobile learning enables self-study with benefits such as flexibility in study time and location, accessibility of data, and adjustment to personal study habits (Duman et al., 2015; Kukulska-Hulme, 2009; Reinders & Pegrum, 2016).

Furthermore, MALL extends beyond the classroom boundaries, empowering students to choose when, where, and how they study (Reinders & Benson, 2017). However, it is essential to note that excessive mobile device use can have negative effects, and the educational benefits of MALL depend on the purpose and quality of the apps used (Hwang & Fu, 2019). Research on commercial language learning apps such as Duolingo, Babbel, and Rosetta Stone has yielded varying outcomes and claims regarding their effectiveness compared to face-to-face courses (Kessler et al., 2023; Vesselinov & Grego, 2012). MALL has garnered increasing attention alongside technological advancements in recent years. The ubiquity of mobile and portable devices has transformed the landscape of technology-assisted studying, prompting a need to evaluate its efficacy in language learning contexts (Elaish et al., 2019; Thornton & Houser, 2005). However, there is a lack of independent research and objective measures to assess the effectiveness of MALL for complete second language improvement (Burston, 2015; Shadieiev et al., 2017).

Technology utilization has become the ultimate solution to the challenges of learning multiple languages, emphasizing the importance of assessing its impact (Elaish et al., 2019;

Hwang & Fu, 2019; Loewen et al., 2019). Mobile devices facilitate a transition from formal to informal language learning contexts (Lai, 2019). Access to learning resources has expanded through various websites and word-to-word translation tools, while mobile apps and web-based content provide language learning tasks and materials (Reinders & Pegrum, 2015; Yousefifard & Fathi, 2021). Language learning apps, such as Duolingo, Rosetta Stone, Lernit, Busuu, Babbel, Memrise, and FluentU, are widely available and offer learners a range of features and approaches (Hwang & Fu, 2019; Loewen et al., 2019). The advantages of mobile-assisted language learning lie in its flexibility, usability, and portability, which provide learners with rich resources and authentic contexts for more effective and enjoyable language learning experiences (Cavus & Ibrahim, 2009; Golonka et al., 2014). Smartphones and digital devices with multi-functionality can support the development of speaking, reading, and listening skills, enabling learners to engage with language learning anytime and anywhere (Elaish et al., 2019; Hwang & Fu, 2019). Mobile learning, encompassing various portable devices, offers flexibility and surpasses the limitations of traditional face-to-face classes (Chen et al., 2020; Loewen et al., 2019).

While mobile apps have their limitations, they remain popular for independent language learning outside the classroom (Burston, 2014). However, it is crucial to recognize that using flashy tools does not guarantee effective learning outcomes. The popularity of mobile learning stems from its convenience, the freedom from reliance on course books, and the opportunity to connect with other language learners, fostering a sense of community and shared learning experiences (Burston, 2015; Heil et al., 2016). Digital devices continually evolve with attractive features that cater to learners' needs. Novel computerized tools make language learning more engaging and personalized, offering learners a unique and interactive learning environment (Chen et al., 2020; Duman et al., 2015). Within MALL apps, Duolingo stands out as a gamified learning environment, boasting an extensive language offering and a vibrant student community.

### **Duolingo in L2 Learning**

Duolingo, a popular language-learning app launched in 2011, has gained widespread recognition and millions of active users across various platforms (Robertson, 2011; von Ahn, 2013). Designed to guide learners to an A2 level in their target language, Duolingo offers interactive features and encourages engagement with other users (Vesselinov & Grego, 2012). Research on Duolingo's effectiveness in language learning has yielded limited results, with studies reporting both positive outcomes and limitations. For instance, Rachels and Rockinson-Szapkiw (2018) found no significant difference in the achievements of students learning Spanish through Duolingo compared to traditional classroom instruction.

Despite variations in research findings, Duolingo remains recognized for its accessibility and affordability (Rachels & Rockinson-Szapkiw, 2018). The app offers various language courses and fosters socialization through language practice events worldwide (Jiang

et al., 2020). It incorporates implicit and explicit learning elements to provide a motivating learning experience (Vesselinov & Greg, 2012; Loewen et al., 2019). Duolingo continually improves its features based on data analysis and user testing, although some exercises remain consistent (Jiang et al., 2020).

In a smartphone experiment by Cavus and Ibrahim (2009), learners reported enjoying the Duolingo experience and acquiring new words, suggesting the potential benefits of incorporating digital tools in language instruction. Duolingo's essential features, such as interval repetition and immediate feedback, contribute to its accessibility and availability anytime and anywhere (Teske, 2017). Spaced repetition in Duolingo helps prevent word fading and improves learner satisfaction (Munday, 2017; Rachels & Rockinson-Szapkiw, 2018).

Comparative studies have also been conducted to evaluate the effectiveness of Duolingo in language learning. Kessler et al. (2023) compared Babbel and Duolingo with adult Turkish learners and found that both groups demonstrated progress in language skills, with no significant differences in learning gains. However, the Babbel group showed a stronger correlation between study time and posttest scores, and participants perceived Babbel as more effective for grammar, speaking/pronunciation, and target language culture. Another study by Loewen et al. (2019) examined the learning experiences of participants studying Turkish on Duolingo for a semester. The findings revealed improvements in L2 measures and a positive correlation between the time spent on Duolingo and learning gains. While learners generally had a favorable view of Duolingo due to its flexibility and gamification, variations in motivation levels and frustrations with instructional materials were observed.

Furthermore, researchers have explored different aspects of Duolingo's impact on language learning. Kessler (2021) conducted a case study involving learners who used Duolingo alongside a reflective e-journal activity, finding that including journals enhanced students' metacognitive awareness in L2 learning. Learners perceived the activity as beneficial and enjoyable. Also, Li and O'Rourke (2022) investigated adult learners' perceptions of a gamified MALL app, focusing on game elements within Duolingo. The study highlighted how the app's storyline and rewards were external motivators, while challenges, progress bars, and competition were internal motivators. Additionally, the storyline facilitated learners' understanding of characters/words in the context of L2 Chinese learning. These findings contribute to our understanding of L2 learning within a gamified MALL context and provide valuable insights for future research.

In conclusion, the current body of research paints a multifaceted picture of Duolingo's role in L2 learning. While its accessibility, affordability, and engaging features contribute to its widespread use, research findings regarding its effectiveness remain mixed. Comparative studies and investigations into specific aspects of Duolingo's impact have provided valuable

insights into its potential benefits, challenges, and user perceptions. Future research in this area is crucial to gain a more comprehensive understanding of Duolingo's long-term effects on L2 learning outcomes and inform the development of effective mobile-assisted language learning strategies.

### **The Present Study**

This study investigates the impact of Duolingo, a ubiquitous mobile language learning application, on two crucial aspects of foreign language acquisition among college students: L2 learning achievement and the development of self-regulated learning (SRL) skills. The burgeoning field of technology-assisted language learning necessitates a deeper understanding of how these tools can foster language proficiency and essential metacognitive skills for lifelong learning success (Hwang et al., 2024).

Examining both L2 achievement and SRL is motivated by several compelling factors. First, research consistently demonstrates a strong link between self-regulated learning and effective language acquisition (Teng & Zhang, 2020). Learners who actively manage their learning processes, setting goals, monitoring progress, and employing various strategies tend to exhibit superior language learning outcomes. Second, TALL tools like Duolingo empower learners with greater autonomy and control over their learning experience, potentially facilitating the development of SRL strategies. However, the specific mechanisms by which Duolingo influences self-regulation remain largely unexplored. Finally, the COVID-19 pandemic has further amplified the need for effective self-regulation as learners navigate often isolated and less-structured learning environments. By investigating how Duolingo might support SRL during this unique period, this study offers valuable insights into leveraging technology to equip learners with essential skills for success.

To gain a comprehensive understanding of Duolingo's potential impact, this study addresses the following research questions:

1. To what extent does the use of Duolingo impact FFL college students' language learning achievement?
2. To what extent does the use of Duolingo influence FFL college students' self-regulated learning in the context of French language learning?
3. What are the attitudes and perspectives of FFL college students towards using Duolingo as a language learning tool?

This study intends to fill a gap in the current research by examining Duolingo's influence on language proficiency and self-regulated learning within the unique context of post-pandemic learning environments. By employing a mixed-methods approach, the study gathers both quantitative and qualitative data, providing a comprehensive and nuanced understanding of Duolingo's potential for second-language learners.



## **Methodology**

This study adopted an explanatory sequential mixed methods design (Ivankova et al., 2006). Quantitative data (standardized tests) was collected first to assess language proficiency, learning achievement, and self-regulated learning. This was followed by qualitative data collection (interviews) to gain deeper insights into participants' experiences and perspectives towards Duolingo, exploring both positive and negative aspects. The mixed methods design allowed data convergence during interpretation, offering a holistic understanding of the research questions and enriching the quantitative findings with qualitative insights. This contributed to a comprehensive narrative on Duolingo's impact on FFL learners' language learning achievement and self-regulated learning.

### **Participants**

This study adhered to the ethical guidelines established by the University of Kurdistan Ethics Committee. Informed consent was obtained from all participants before participating, and the committee approved the study procedures.

A convenience sample of 48 Iranian college students majoring in English was recruited from the University of Kurdistan, Iran. The participants were male and female students aged 18 to 22 ( $M = 20.89$ ,  $SD = 1.98$ ). All participants were pursuing a bachelor's degree in English literature and were enrolled in introductory French courses as part of their required curriculum. It is essential to clarify that participation in the research component of this course was entirely voluntary. Students could participate in the study after being informed of its purpose, procedures, and potential risks and benefits. This clarification ensures transparency and addresses ethical concerns regarding informed consent and potential coercion due to the mandatory nature of the French course.

### **Instruments**

#### **Placement Test**

A teacher-made French placement test was administered to ensure homogeneity of participants' pre-existing French language proficiency before the treatment phase. The test consisted of eight items, evaluating grammar and vocabulary skills using various question formats such as pairing, matching, and gap-filling exercises. The placement test was administered in a printed format with a designated time of 40 minutes for completion. The placement test results were used to create a homogenous group of participants with similar levels of French language proficiency, minimizing the potential influence of pre-existing knowledge gaps on the study's findings.

To ensure the suitability of the placement test for assessing participants' language proficiency, a pilot study was conducted with a sample of 25 individuals with characteristics similar to the main study population. This pilot allowed for the evaluation of the test's

psychometric properties, which are essential for establishing its effectiveness in measuring the intended construct (French language proficiency in this case).

Internal consistency, reflecting the degree to which the test items measure the same underlying skill, was assessed using Cronbach's alpha, resulting in a coefficient of 0.83. This value indicates acceptable reliability, demonstrating that the test consistently measures a single underlying construct across multiple administrations. Content validity, ensuring the test items represent the intended content domain, was established through review by subject matter experts who assessed the alignment of test items with recognized French language proficiency criteria at the targeted level.

To further strengthen the assessment of face validity, which focuses on participants' perceptions of the test's relevance and appropriateness, a small group of participants provided feedback on the test items' clarity, comprehensiveness, and representativeness. Their feedback confirmed the appropriateness of the test for assessing the targeted language skills. Based on the pilot study results demonstrating satisfactory reliability and validity, the placement test was deemed suitable for its intended purpose in the main study.

### **Language Achievement Test**

Following the placement test, a teacher-made achievement test was used as a pretest and a posttest to measure participants' French language learning achievement. This test comprised eight items, each consisting of several sub-items. The posttest differed from the pretest regarding specific items, but the overall difficulty level and number of items remained consistent. The test items were designed to evaluate participants' grammar and vocabulary skills, similar to the pretest. The language achievement test was administered online.

While the allotted time for test completion was 40 minutes, participants were permitted to finish and submit their answers earlier if they had completed the test. This approach aimed to balance efficient data collection with participant convenience and to accommodate individual differences in completion speed, especially considering the open-ended nature of some sub-items within the eight items.

A rigorous quality assurance process was employed to enhance the reliability and validity of the language achievement test. Expert reviewers with language assessment reviewed and verified the test questions, contributing to the overall reliability and validity of the instrument used in the study. By employing the same achievement test at both time points, the study controlled for potential pre-existing differences in learning styles or test-taking strategies that might have influenced the results.

### **Self-Regulated Questionnaire (SRQ)**

A self-regulated questionnaire was utilized to gather participant insights based on Seker's (2016) development. Drawing on the theoretical foundations of Boekaerts' (1997) "Self-

Regulated Learning Model" and Oxford's (1990) "Strategy Inventory for Language Learning (SILL)," the questionnaire consisted of 30 items. It was administered using Google Forms, employing a Likert scale format with a five-point rating system—from 1 (strongly disagree) to 5 (strongly agree). Minor adaptations were made to align the questionnaire with the study's context, replacing "English" with "French" in most items and modifying item 16 to reflect "French" and "English" translations. The questionnaire's relevance and appropriateness were thus ensured. The reliability of the questionnaire was assessed using internal consistency measures, revealing a reliability coefficient of 0.86 during the pretest phase and 0.74 during the posttest phase (Cronbach's alpha). These coefficients demonstrate high internal consistency, indicating that the questionnaire consistently measures the construct of interest.

### **Interviews**

To gain deeper insights into participants' experiences and perspectives on Duolingo's effectiveness, eight volunteer learners from the experimental group participated in semi-structured interviews (see the Appendix) conducted by a trained researcher. These in-person sessions, lasting approximately 30 minutes each, allowed for in-depth exploration of individual viewpoints.

A comprehensive interview guide facilitated these discussions, consisting of open-ended and probing questions designed to elicit rich information. The guide covered themes such as participants' prior French language learning experiences and motivations for using Duolingo, their perceptions of the app's strengths and weaknesses as a learning tool, how they integrated Duolingo with other learning strategies, and their perceived impact of the app on their language learning progress and self-regulated learning skills.

Several measures were taken to ensure the interview data's trustworthiness and credibility. A pilot interview with a volunteer outside the study sample helped refine the interview guide and provide clarity and comprehensiveness of the questions. Additionally, participants were offered the opportunity to review and, if needed, clarify or modify their responses after the interviews, enhancing the accuracy and participant voice in the data.

The semi-structured approach was deliberately chosen to balance consistency and flexibility. In contrast, predetermined questions ensured coverage of critical themes, and follow-up prompts and probes allowed us to explore unique participant experiences and perspectives. This approach ultimately facilitated a more nuanced understanding of the participants' journeys with Duolingo.

### **Duolingo**

Duolingo is a widely recognized language learning application that incorporates gamification elements to engage users. It offers various language options, including French, German, Turkish, Spanish, and more, accessible through its website and mobile apps on IOS and

Android platforms. It employs interactive exercises like matching items, translation tasks, pronunciation practice, and sentence sorting to enhance language learning. Its gamification features motivate users to participate actively in their language-learning journey. Also, the instructors used Duolingo for Schools. It is a valuable feature that allows teachers and researchers to monitor students' progress and engagement within the app. It provides insights into individual and group performance, facilitating a comprehensive language acquisition assessment. Additionally, Duolingo for Schools enables educators to assign language learning activities as homework, promoting consistent practice and reinforcing classroom learning. This feature extends the application's usefulness as an effective tool for language education in academic settings (Loewn et al., 2019).

While the primary measurement of language achievement in this study utilized written tests, it is essential to acknowledge that Duolingo, as a multimedia app, strengthens multiple aspects of language skills beyond vocabulary and grammar. The app's integration of audio, visual, and interactive elements aligns with research indicating that multimedia input can enhance receptive skills (listening and reading comprehension) and support the development of implicit knowledge (Liu & Leveridge, 2017). This tacit knowledge forms the foundation for explicit written production, which the tests were designed to measure. While the written tests might not comprehensively capture the full range of skills developed through Duolingo, they offer essential insights into learners' foundational vocabulary and grammar, which are crucial building blocks for overall language proficiency.

## **Procedure**

### **Pre-Treatment Stage**

Participants were selected using convenience sampling from English literature students at the University of Kurdistan, Iran. Forty-eight students (31 girls, 19 boys) in their second term, aged 18 to 22, were included. The French course held once a week for one and a half hours, was required for their bachelor's degree. The research spanned a whole semester, consisting of 16 sessions.

The instructor, who had 12 years of experience teaching French, held a master's degree in French language and was responsible for teaching the French course at the university. To ensure the homogeneity of the students, a French language achievement pretest was conducted one week before the course began. The pretest was administered online via Google Forms and took approximately 40 minutes. It consisted of 8 items assessing vocabulary knowledge and grammar skills. Additionally, a self-regulation questionnaire with 30 items was administered via Google Forms, requiring a maximum of 10 minutes to complete.

After developing the research instructions, the learners were assigned to experimental groups (n=25) and control groups (n=23). The students were not informed about the research.

Although the experimental and control groups were at the same level of French proficiency, they were taught separately by the same instructor. The Taxi book, a French book, was introduced to both groups as a sourcebook. Due to time constraints, only pages 12 to 29 of the book were covered in class.

In addition to attending their traditional classroom instruction, the experimental group used Duolingo as a supplementary tool. The instructor assigned specific Duolingo lessons focusing on topics directly related to the content covered in the Taxi textbook. To ensure alignment, the instructor adapted some Duolingo lessons to match the specific vocabulary and grammar points covered in the classroom sessions. After each new lesson in class, the experimental group was assigned a corresponding Duolingo lesson to complete individually outside the classroom. This individual practice aimed to solidify their understanding of the newly introduced concepts in a self-paced, interactive environment. Only skill-building lessons focused on grammar, vocabulary, and pronunciation exercises were assigned on Duolingo. Stories and podcasts were excluded from the assigned lessons, which often involve a more comprehensive range of vocabulary and may not directly align with the classroom content. The instructor primarily used English to deliver the classroom content, occasionally switching to Farsi for clarification when necessary.

Throughout the research, the researcher remained anonymous in both the experimental and control classes. Since Duolingo usage occurred outside the class, students were unaware of the researcher's involvement. However, the instructor was aware of the researcher's presence as they collaborated. The researcher assigned Duolingo lessons for the students' accounts, tracked their progress, and monitored their engagement time with Duolingo for Schools.

### **Treatment Stage - Experimental Group**

The instructor introduced the course curriculum and Taxi as the sourcebook in the first session. Duolingo was introduced as a supplementary tool in the same session. The instructor emphasized its popularity and encouraged students to join the class created in Duolingo for schools through a shared WhatsApp group link. Students were instructed to complete assignments independently and focus on learning without time restrictions.

The second session began with a review of the French alphabet and pronunciation practice. No Duolingo usage was assigned for this session. The instructor then taught numbers, focusing on pronunciation, and assigned the "Shopping" and "Hotel" lessons in Duolingo as practice. In the third session, students read numbers aloud and engaged in a game to enhance fluency. The lesson "Bienvenue" (Taxi, page 14) was introduced, covering basic greetings. Toward the end of the session, students were assigned the "greeting" lesson in Duolingo.

In the fourth session, the instructor revisited the conversation, added new sentences, and encouraged role-play. The "greeting" lesson in Duolingo was continued. Grammar instruction took place in the fifth session (Taxi, page 14), followed by exercises in the book and completion of the "Basic 1" lesson in Duolingo.

In the sixth session, the instructor reviewed previous content, introduced a new lesson through a conversation, and explained grammar rules regarding singular and plural nouns (Taxi, page 16). The "travel" lesson in Duolingo was recommended. The seventh session focused on checking exercises, reviewing a conversation (Taxi, page 18), and assigning the "people" lesson in Duolingo.

Session eight involved conversation memorization, sentence meaning clarification, and introduction of new grammar (Taxi, page 18). The instructor assigned the "Travel and Family" lessons in Duolingo. In the ninth session, grammar exercises were completed, with challenging exercises explained by the instructor. A lesson on self-introduction (Taxi, page 20, 21) was also taught, followed by students writing a paragraph about themselves and completing the "Basic 2" and present tense one lessons in Duolingo.

Session ten began with addressing student questions regarding the final exam. Students then introduced themselves in French and engaged in conversation exercises. In session eleven, a warm-up activity followed a conversation from page 24, a grammar explanation, and an assignment of the "at home and people 2" lessons in Duolingo for the next session.

Session twelve commenced with a student reading the conversation, followed by a grammar review and exercises from page 25. The instructor demonstrated object placement using a student's book and bag. The session ended with a quick reading of the conversation on page 26, leaving the lesson continuation for the next session.

A warm-up activity was conducted in session thirteen, followed by a student conversation. The instructor explained grammar (page 26) and encouraged students to create similar sentences. The "lessons agreement and people 3" in Duolingo were recommended. Session fourteen involved grammar explanation (page 27), exercise completion, and student participation in sentence creation. The last lesson of the term, "Shopping" (Taxi, page 28), included role-plays, followed by the assignment of the "Shopping" lesson in Duolingo.

The final session of the fifteen began with a grammar explanation (page 28) and example sentences. Students completed related exercises, and the answers were reviewed. Duolingo's "food lesson" was introduced, aligning with the grammar rules. Students were advised to prepare for the final exam three weeks after the session.

### **Treatment Stage - Control Group**

The control group underwent traditional in-class French education, following the same procedures as the experimental group. All assignments and activities from the Taxi book were replicated for the control group. The instructor provided the control group with an

education equivalent to that of the treatment group, with the only difference being that the control group used the PDF content of Duolingo for schools instead of the app itself. After covering each lesson in class, the instructor sent the Duolingo PDF content to the control group via WhatsApp. This ensured that the primary distinction between the groups was using Duolingo for schools rather than the content itself.

Like the experimental group, the instructor explained the curriculum in the first session. He created a WhatsApp group for the students to join and informed them that he would share PDFs for additional practice. The instructor tracked their progress through their exercises. While he did not mention Duolingo to the control group, he instructed them to join a link shared in the WhatsApp group, emphasizing that it was a part of the course process. The instructor aimed to ensure that none of the control group students used Duolingo, as Duolingo for schools allows teachers to track student progress.

In the subsequent sessions, the instructor taught the French alphabet, pronunciation, and numbers to the control group, following the same methods used with the experimental group. The instructor reviewed previous lessons, checked pronunciation, and engaged students in warm-up questions and activities. Each session focused on specific lesson content, including greetings, basic sentences, grammar, and conversations covered in the Taxi book. The instructor shared relevant PDFs in the WhatsApp group for additional practice and required students to send their exercises and notes via WhatsApp to ensure their participation.

The instructor encouraged student engagement throughout the sessions through reading aloud, role-playing, and discussions. He used whiteboard explanations, correction exercises, and examples to clarify grammar rules. The instructor ensured that the control group had access to PDF materials and emphasized their relevance to the book content. The sessions culminated in the instructor preparing the students for their final exam by providing details about the written exam and its timing while not mentioning the interview component.

### **Post-Treatment Stage**

After three weeks, the instructor administered the posttest self-regulation questionnaire to both groups using Google Docs for the second time. Participants were asked to answer the 30-item questionnaire, which took approximately 10 minutes. Additionally, all participants in both groups took the posttest exam, which lasted 40 minutes. The posttest exam had questions that were different from the pretest but were at the same difficulty level.

Furthermore, eight learners from the experimental group were selected for in-person personal interviews. The interviews, conducted by the researcher in English, followed a semi-structured format with predetermined questions that could be adapted based on the context or respondent. The interviews lasted around thirty minutes each.

### **Data Analysis**

This study employed an explanatory sequential design (Ivankova et al., 2006), where data from the quantitative phase was collected first, followed by the qualitative phase. The

purpose of the qualitative phase was to provide further insights into the findings obtained in the quantitative phase. Both descriptive and inferential statistics were used to analyze the collected data.

To assess within-group progress, paired sample t-tests were conducted, comparing pretest and posttest scores for both achievement and self-regulation variables within each group. Additionally, ANCOVA (analysis of covariance) was employed to measure between-group differences. ANCOVA was preferred over an independent samples t-test to control for the potential influence of pre-existing knowledge on posttest scores, thus providing a more precise estimate of the treatment effect on L2 learning achievement (Field, 2013). This statistical approach allowed for a rigorous examination of the intervention's impact while mitigating the confounding effects of participants' baseline proficiency levels. The assumptions of ANCOVA, including linearity, homogeneity of variances, independence of errors, and normality of residuals, were checked prior to conducting the analysis.

The qualitative phase aimed to enrich the quantitative findings by exploring the attitudes and perspectives of Duolingo users. Following the method proposed by Auerbach and Silverstein (2003), content analysis was employed to analyze the qualitative data. This involved systematically examining interview transcriptions to identify recurring themes and patterns in participants' responses.

## Results

### *Quantitative Phase*

In Table 1, descriptive statistics are presented for L2 achievement and self-regulation variables in both the experimental and control groups. The mean scores, standard deviations (SD), and standard errors (SE) for the pretest and posttest measurements are provided. For the pretest of achievement, the experimental group had a mean score of 8.83 ( $SD = 2.636$ ,  $SE = .527$ ), whereas the control group had a mean score of 8.5589 ( $SD = 2.825$ ,  $SE = .589$ ). In terms of posttest scores of achievements, the experimental group showed a mean score of 18.44 ( $SD = 3.629$ ,  $SE = .725$ ), while the control group had a mean score of 14.65 ( $SD = 3.124$ ,  $SE = .651$ ).

**Table 1**  
*Descriptive Statistics for the Study Variables*

	Group	N	Mean	Std. Deviation	Std. Error Mean
Achievement1	Experimental	25	8.8334	2.63653	.52731
	Control	23	8.5589	2.82596	.58925



Achievement2	Experimental	25	18.4400	3.62951	.72590
	Control	23	14.6522	3.12408	.65142
Self.Regulation1	Experimental	25	3.0480	.48229	.09646
	Control	23	3.2348	.49046	.10227
Self.Regulation2	Experimental	25	4.1268	.56523	.11305
	Control	23	3.5696	.55221	.11514

Regarding pretest self-regulation scores, the experimental group exhibited a mean score of 3.048 ( $SD = .482$ ,  $SE = .096$ ), whereas the control group had a mean score of 3.23 ( $SD = .490$ ,  $SE = .102$ ). Concerning posttest self-regulation scores, the experimental group had a mean score of 4.12 ( $SD = .565$ ,  $SE = .113$ ), while the control group showed a mean score of 3.56 ( $SD = .552$ ,  $SE = .115$ ).

**Table 2**

*Results of the Paired Samples Test for the Experimental Group*

Paired Differences		M	SD	t	df	Sig. (2-tailed)
Pair 1	Achievement1 - Achievement2	-9.60	2.80	-17.14	24	.000
Pair 2	Self.Regulation1 - Self.Regulation2	-1.07	.26	-20.42	24	.000

Then, paired-samples t-tests were conducted to assess the progress from the pretest to the posttest for both L2 achievement and self-regulation variables within each group. The results of the t-tests for the experimental group are presented in Table 2. For pair 1, there was a significant difference between achievement scores at time 1 ( $M = -9.606$ ,  $SD = 2.802$ ,  $SE = .560$ ) and achievement scores at time 2,  $t(24) = -17.140$ ,  $p < .001$ . This indicates a substantial improvement in L2 achievement within the experimental group. Similarly, for pair 2, a significant difference was observed between self-regulation scores at time 1 ( $M = -1.078$ ,  $SD = .264$ ,  $SE = .052$ ) and self-regulation scores at time 2,  $t(24) = -20.421$ ,  $p < .001$ . This suggests a notable enhancement in self-regulation skills within the experimental group. These findings indicate that, within the experimental group, there were significant improvements in both L2 achievement and self-regulation measures. The participants demonstrated enhanced language achievement and self-regulated learning throughout the intervention.

**Table 3***Results of the Paired Samples Test for the Control Group*

Paired Differences		M	SD	t	df	Sig. (2-tailed)
Pair 1	Achievement1 - Achievement2	-6.09	1.39	-20.88	22	.000
Pair 2	Self.Regulation1 - Self.Regulation2	-.334	.28	-5.56	22	.000

Table 3 presents the results of paired-samples tests conducted to analyze the differences within the control group for Pair 1 (achievement1 - achievement2) and Pair 2 (self-regulation1 - self-regulation2). For pair 1, there was a statistically significant difference between achievement scores at time 1 ( $M = -6.093$ ,  $SD = 1.39927$ ,  $SE = .291$ ) and achievement scores at time 2,  $t(22) = -20.884$ ,  $p < .001$ . This indicates a substantial improvement in achievement within the control group.

Similarly, for pair 2, a significant difference was found between self-regulation scores at time 1 ( $M = -.334$ ,  $SD = .288$ ,  $SE = .060$ ) and self-regulation scores at time 2,  $t(22) = -5.564$ ,  $p < .001$ . This suggests a notable enhancement in self-regulation skills within the control group. These findings indicate that, within the control group, there were significant differences in both achievement and self-regulation measures from pretest to posttest. The participants in the control group demonstrated improvements in both achievement and self-regulation throughout the study.

**Table 4***ANCOVA Results for L2 Achievement*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Achievement1	300.691	1	300.691	58.783	.000	.566
Group	148.939	1	148.939	29.117	.000	.393
Error	230.186	45	5.115			

Subsequently, one-way ANCOVAs were conducted to examine the effect of Duolingo-based language instruction on L2 achievement while controlling for the pretest scores. The results of the ANCOVA are presented in Table 4. The ANCOVA results indicated that the effect of Duolingo-based language instruction on L2 achievement was statistically significant ( $F(1, 45) = 29.117$ ,  $p < .001$ ,  $\eta^2_{\text{partial}} = .393$ ). This suggests that,

even after accounting for the influence of pretest scores, the intervention substantially impacted L2 achievement. Approximately 39.3% of the variance in L2 achievement can be attributed to group membership.

These findings highlight the significant contributions of the Duolingo-based language instruction intervention to L2 achievement. The intervention significantly improved participants' L2 achievement beyond the influence of their initial proficiency levels. The results underscore the effectiveness of the intervention in promoting L2 learning outcomes.

Table 5  
*ANCOVA Results for Self-regulation*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Self.Regulation	10.870	1	10.870	139.490	.000	.756
Group	6.385	1	6.385	81.939	.000	.645
Error	3.507	45	.078			

Similarly, one-way ANCOVAs were conducted to examine the effect of Duolingo-based language instruction on self-regulation while controlling for the pretest scores. The ANCOVA results for self-regulation are presented in Table 5. The results revealed that the effect of Duolingo-based language instruction on self-regulation was statistically significant ( $F(1, 45) = 81.939, p < .001, \eta^2_{\text{partial}} = .645$ ). This indicates that, even after accounting for the influence of pretest scores, the intervention substantially impacted participants' self-regulation. Approximately 64.5% of the variance in self-regulation can be attributed to group membership.

These findings underscore the significant influence of Duolingo-based language instruction in explaining the variability in self-regulation. The intervention substantially enhanced participants' self-regulation skills beyond the impact of their initial self-regulation levels. The results highlight the effectiveness of the intervention in promoting self-regulated learning and developing learners' abilities to regulate their language learning processes.

### **Qualitative Phase**

The qualitative phase of the study aimed to explore the attitudes and perspectives of Duolingo users, providing insights into both positive and negative views towards the application. Most Duolingo users expressed positive opinions about the app, considering it

beneficial, easy to use, and suitable for language learners. Participants highlighted the following aspects:

### ***Duolingo as a Beneficial App for Beginners***

Participants found Duolingo a valuable and helpful tool in their language-learning journey. They appreciated how the app catered to beginners, assisting them in learning various languages. The accessibility and cost-free nature of Duolingo made it highly applicable among users. One participant expressed their positive experience, stating, "*Duolingo was beneficial and useful for me. It was not difficult to use, and I found it easy to navigate. It was particularly suitable for beginners like me, as it considered our level of proficiency*" (Student A, interview session, June 2022).

### ***Motivating Gamified Learning Environment***

The gamification aspect of Duolingo stood out as a motivating feature for learners. The game-like activities and interactive elements made language learning enjoyable, encouraging users to spend more time with the app without realizing how quickly time passed. Another participant commented on this aspect: "*The game-like activities in Duolingo kept me engaged. I didn't even notice how quickly time passed while using the app*" (Student B, interview session, June 2022).

### ***Social Interaction and Community Engagement***

Participants voiced their interest in integrating social interaction features into Duolingo, highlighting the value of practicing language skills with fellow users and engaging in community discussions. They believed that social elements within the app would enhance the language learning experience and foster a sense of belonging. One student said, "*It is fantastic that Duolingo has a feature that allows us to interact with other learners. I would love to have conversations with fellow learners, practice speaking, and receive feedback from others*" (Student C, interview session, June 2022).

### ***Customization and Personalization***

Several participants highlighted the advantage of having more customization options in Duolingo. They maintained that the app's potential in personalizing the content and exercises according to their individual learning needs and goals was beneficial to their learning. Participants believed a more personalized learning experience could enhance their motivation and engagement with the app. One participant expressed this sentiment during an interview, stating, "*It was great that Duolingo allowed us to customize our learning path. Having the flexibility to choose what I want to focus on would make the app even more effective for me*" (Student D, interview session, June 2022).

### ***Pronunciation and Speaking Practice***

Several participants emphasized the importance of honing pronunciation and speaking skills in language learning. They maintained that Duolingo could provide opportunities for oral practice, such as through the integration of voice recognition technology or interactive speaking exercises. One participant said, *"I liked that Duolingo introduced more speaking exercises to improve our pronunciation. It seems great that the app can listen to our speech and give us feedback on our pronunciation accuracy. This way, we could enhance our speaking abilities alongside other language competencies"* (Student E, interview session, June 2022). These participants believed these aspects would contribute significantly to a comprehensive language-learning experience.

Although the overall sentiment towards Duolingo was positive, participants also raised some concerns and areas for improvement:

### ***Duolingo as a Complementary App***

Some learners regarded Duolingo as a complementary tool rather than a standalone solution for language learning. They emphasized that while the app proved beneficial for beginners, it lacked comprehensiveness in fully developing language proficiency. Participants felt that additional resources, such as books and external materials, were necessary to enhance their language skills, thereby challenging Duolingo's claim as an independent learning tool. A participant expressed this viewpoint: *"I think Duolingo is not complete enough, and you need some books and extra sources in addition to the app. You need other sources to improve your language skills"* (Student A, interview session, June 2022).

### ***Lack of an Embedded Glossary***

Furthermore, participants noted a lack of an embedded glossary in Duolingo, which they believed would greatly assist in learning the meanings and contexts of words. They stressed the advantage of having a glossary for each lesson, as it would facilitate better understanding and engagement with the words and their usage. A participant aptly remarked, *"Not having a glossary for each lesson is a disadvantage. A glossary could help learners better understand the meaning and contexts of words"* (Student B, interview session, June 2022).

In conclusion, the qualitative phase of the study provided valuable insights into the attitudes and perspectives of Duolingo users. Most participants expressed positive views towards the app, highlighting its benefits as a valuable and user-friendly tool for language learners. Participants appreciated Duolingo's accessibility, gamified learning environment,

and potential for social interaction and community engagement. They also desired more customization options and enhanced pronunciation and speaking practice within the app. However, participants also raised concerns, viewing Duolingo as a complementary rather than a standalone learning tool and emphasizing the need for supplementary resources and an embedded glossary. These findings provide meaningful guidance for developers and educators aiming to improve the Duolingo experience and better meet the needs of language learners.

## **Discussion**

This study aimed to investigate the impact of Duolingo-based instruction on L2 learning achievement and self-regulated learning among FFL students. The findings from this study contribute to our understanding of the effectiveness of Duolingo as a supplementary tool in language learning and shed light on the role of self-regulated learning in the language learning process.

The first finding was that Duolingo-based language instruction significantly impacted L2 achievement. This finding aligns with the extant bulk of literature reporting the usefulness of MALL in L2 learning (e.g., Elaish et al., 2019; Heil et al., 2016; Kessler et al., 2023; Loewen et al., 2019; Rachels & Rockinson-Szapkiw, 2018; Shadiev et al., 2017). This result suggests that as a digital language learning tool, Duolingo can effectively contribute to developing foreign language skills. One theoretical framework that supports this finding is the Input Hypothesis proposed by Krashen (1985). According to this hypothesis, language acquisition occurs when learners are exposed to comprehensible input, i.e., language input, slightly beyond their current level of proficiency. Duolingo's interactive exercises and gamified approach provide learners ample opportunities for exposure to meaningful input, thus facilitating language acquisition (Kessler et al., 2023; Loewen et al., 2019; Rachels & Rockinson-Szapkiw, 2018). The repeated exposure to vocabulary, grammar structures, and contextual language use within Duolingo's lessons and exercises may contribute to the development of foreign language achievement among learners (Leow, 1998; Matsumura, 2003).

Furthermore, the adaptive learning features of Duolingo, which customize the difficulty level based on learners' performance, can contribute to foreign language achievement (Rachels & Rockinson-Szapkiw, 2018). This adaptive nature of Duolingo ensures that learners are consistently challenged without feeling overwhelmed, enabling them to make incremental progress and solidify their learning. By offering personalized feedback and adjusting task difficulty, Duolingo fosters engagement and motivation, which is vital for successful language learning (Dornyei, 2019; Yu et al., 2023).

In addition, Duolingo's use of multimedia elements like audio recordings and visuals can enhance learners' listening and reading comprehension (von Ahn, 2013). Research

suggests that learning environments enriched with multimedia can promote engagement, attention, and cognitive processing, ultimately leading to better learning outcomes (Aydın & Çakır, 2022; Liu et al., 2014). By presenting language materials in a multimodal format, Duolingo provides learners with diverse and engaging input, which aligns with established theories on language acquisition through exposure (Krashen, 2014; Ranalli, 2008) and contributes to their overall foreign language proficiency.

Furthermore, the accessibility and availability of Duolingo as a mobile application enable learners to practice and reinforce their language skills beyond the confines of traditional classroom settings (Loewen et al., 2019). This flexibility in learning opportunities allows learners to engage with the language at their own pace and convenience, potentially leading to increased exposure and practice (Wong et al., 2013). The additional exposure and practice facilitated by Duolingo can improve foreign language achievement among learners.

Furthermore, the study revealed that Duolingo-based language instruction had a notable impact on the self-regulated learning of the participants, aligning with theories of self-regulation and the advantages of technology in fostering metacognition and learner autonomy (Lei et al., 2022; Rahimi & Fathi, 2022). Self-regulated learning involves learners actively planning, monitoring, and evaluating their learning activities to achieve specific goals (Zimmerman, 1990, 2002). Duolingo's platform provides opportunities for self-directed and independent learning experiences, facilitating the development of self-regulatory behaviors (Yang, 2016). The adaptive learning environment of Duolingo allows learners to set their own pace and progress through the content according to their abilities (Rachels & Rockinson-Szapkiw, 2018; Vesselinov & Grego, 2012). Learners can choose which lessons to undertake, and the app adjusts the difficulty level based on their performance (Cavus & Ibrahim, 2009).

The adaptive system of Duolingo empowers learners to take control of their learning journey and make decisions regarding their path, fostering autonomy and self-determination, both crucial aspects of self-regulated learning (Hawkins, 2018; Loewen et al., 2019). Additionally, the gamified nature of Duolingo serves as a motivating factor, actively engaging learners in the learning process (Rachels & Rockinson-Szapkiw, 2018). Through gamification elements like earning points, leveling up, and receiving badges, learners receive extrinsic rewards that can enhance their intrinsic motivation (Boudadi & Gutiérrez-Colón, 2020; Flores, 2015). As learners progress and accomplish tasks within the app, they experience a sense of achievement and fulfillment, further reinforcing their self-regulated learning behaviors.

In addition, Duolingo provides learners with immediate feedback and progress-tracking features, enabling them to monitor their performance and identify areas for improvement. Learners can evaluate their learning strategies and make necessary adjustments by receiving timely feedback on their responses and tracking their progress

throughout the lessons (Fathi et al., 2019; Hwang & Fu, 2019). This metacognitive aspect of self-regulated learning, involving the monitoring and regulation of one's cognitive processes, is facilitated by Duolingo's real-time feedback mechanism (Heil et al., 2016; Schunk, 2008). Furthermore, Duolingo incorporates various cognitive strategies, such as spaced repetition, retrieval practice, and elaboration, into its language learning exercises. These strategies have been found to promote effective learning and enhance long-term retention of information (Elaish et al., 2019; Fritz et al., 2007). By engaging with these cognitive strategies during their Duolingo practice, learners may develop a deeper awareness of their learning processes, establish connections between different concepts, and improve their ability to organize and manage their learning independently.

Finally, Duolingo's mobile application allows learners to engage with the language learning material anytime and anywhere (Burston, 2015; Li & Bonk, 2023). This accessibility encourages learners to use microlearning opportunities, where short and frequent study sessions can be integrated into their daily routines (Gorham et al., 2023; Yin et al., 2021). Microlearning has improved knowledge retention and self-directed learning (García Botero et al., 2019); learners can practice self-regulation in managing their learning schedule by having control over when and where they study.

Meanwhile, the qualitative phase of the study provided valuable insights into the attitudes and perspectives of Duolingo users, revealing a spectrum of views encompassing both positive and negative sentiments. Participants conveyed positive opinions about Duolingo, characterizing it as a beneficial, user-friendly, and apt application for language learners. Key themes emerged from participants' feedback, emphasizing the app's advantages for beginners and its supportive role in learning various languages. Users particularly appreciated Duolingo's accessibility and cost-free nature, facilitating a seamless initiation into their language learning journey without significant barriers (Stapleton & Radia, 2010). The gamified learning environment of Duolingo emerged as a noteworthy aspect that participants appreciated. Incorporating game-like activities and interactive elements added an enjoyable dimension to language learning, fostering motivation among users to actively engage with the app (Bahari, 2022). Participants even reported losing track of time due to the captivating nature of these activities, underscoring the pivotal role of gamification in sustaining their motivation throughout the learning experience (Rachels & Rockinson-Szapkiw, 2018).

Also, the participants expressed a desire for more social interaction features within Duolingo, emphasizing the importance of practicing language skills with other users and engaging in community discussions. They believed incorporating social elements, such as conversation features, speaking practice, and feedback exchange, would enhance language learning and foster a sense of community (Duff, 2019; Fathi et al., 2019; Nicol et al., 2003). Participants also valued customization and personalization. They expressed the need for more



options to tailor the app's content and exercises to their specific learning needs and goals (Fathi & Rahimi, 2022; Lai et al., 2018). Participants believed that a personalized learning experience would increase their motivation and engagement (Chen et al., 2021; Ma, 2017). They desired the ability to choose relevant topics and focus areas instead of feeling constrained by repetitive or irrelevant content.

Additionally, participants recognized the significance of pronunciation and speaking practice in language learning. They expressed a strong desire for Duolingo to provide more opportunities for practicing oral skills, such as through the integration of voice recognition technology or interactive speaking exercises. They believed that improving these aspects would contribute to a more comprehensive language-learning experience. They highlighted the importance of receiving feedback on pronunciation accuracy to enhance their speaking skills alongside other language competencies. While participants generally had a positive sentiment towards Duolingo, they also raised concerns and areas for improvement. Some learners viewed Duolingo as a complementary tool rather than a standalone solution for language learning, suggesting the need for additional resources to enhance language proficiency. Participants believed books and external materials were necessary for a more holistic approach. Another concern raised by participants was the lack of an embedded glossary in Duolingo. They emphasized the advantage of having easy access to word definitions within the app, which would enhance vocabulary acquisition and comprehension.

## **Conclusion**

This study investigated the impact of Duolingo, a mobile language learning application, on L2 learning achievement and self-regulated learning skills among FFL college students. Employing a mixed methods design, the research yielded valuable insights into the potential of Duolingo to contribute to language learning outcomes and foster learner autonomy.

The quantitative findings demonstrated that the Duolingo experimental group exhibited statistically significant improvement in their French language proficiency scores compared to the control group. This finding aligns with the SCT, which posits that individuals learn through observing, imitating, and practicing behaviors demonstrated by others (Bandura, 1986). Duolingo's interactive format and gamified elements likely allowed learners to observe and practice target language structures and vocabulary, contributing to their L2 development.

The qualitative analysis of the semi-structured interviews revealed that students using Duolingo reported increased autonomy and ownership over their learning. They described strategies for setting goals, monitoring progress, and utilizing various Duolingo features to personalize their learning experience. These findings resonate with Self-Determination Theory (SDT), which emphasizes the importance of autonomy, competence, and relatedness

in motivating and sustaining intrinsic motivation for learning (Deci & Ryan, 2000). Duolingo's flexible structure and personalized learning approach may have fostered a sense of control and choice among learners, potentially contributing to their intrinsic motivation and self-regulated learning skills.

In conclusion, this study not only contributes to the empirical evidence on the effectiveness of Duolingo in L2 learning but also sheds light on its potential role in supporting self-regulated learning. The findings support the theoretical frameworks of SCT and SDT, suggesting that Duolingo can contribute to language acquisition by providing opportunities for observation and practice and fostering learner autonomy. Also, our insights strongly advocate for integrating technology-enhanced language learning practices to cultivate students' linguistic abilities, self-regulation skills, and passion for learning. Embracing the potential of technology in education becomes imperative for policymakers, educators, and language practitioners alike as they strive to create supportive environments that leverage technology's benefits to empower and nurture language learners in the post-COVID-19 era and beyond.

The findings of this study hold significant implications for various stakeholders involved in language learning, including educators, practitioners, developers, and policymakers. Educators and practitioners can leverage Duolingo as a valuable supplementary tool within their curricula. Its gamified and interactive features can promote engagement and self-regulated learning skills (goal setting, self-reflection) among learners, ultimately contributing to increased learner autonomy and proficiency development. However, it's crucial to remember that Duolingo should not replace existing pedagogical approaches, and educators should curate its use effectively to complement their existing methods. Also, catering to individual needs is crucial. As highlighted by the participants' desire for more customization, educators and developers should strive to create differentiated learning experiences that address individual learner needs, interests, and learning styles. This can involve providing customizable difficulty levels, personalized feedback mechanisms, and diverse learning pathways within language learning applications.

For technology developers, the positive learner response to Duolingo's gamified elements offers valuable insights. Similar features like points, badges, leaderboards, and interactive exercises can enhance learner motivation and engagement within their applications. Furthermore, integrating adaptive learning algorithms can tailor the learning experience to individual progress, further optimizing engagement and effectiveness. Additionally, exploring advanced voice recognition technology can significantly improve pronunciation practice and provide learners with valuable feedback. Moreover, incorporating social features like collaborative tasks, discussion forums, and language exchange opportunities can foster peer learning and community engagement (Fathi & Rahimi, 2022; Liu et al., 2022).

Policymakers and educational institutions, including Duolingo, can actively support integrating technology into language learning curricula. This can be achieved by providing funding, resources, and professional development opportunities for educators to effectively incorporate technology and promote self-regulated learning strategies in their classrooms.

Future research directions include examining the sustainability of Duolingo-based instruction through long-term studies and tracking learners' progress over extended periods. Conducting comparative studies that explore the effectiveness of Duolingo against other tools and traditional approaches can shed light on their strengths and weaknesses, informing evidence-based decisions about language learning strategies. Additionally, investigating the effectiveness of Duolingo among diverse learner populations such as advanced learners, beginners, or individuals with specific learning needs can inform its application in varied educational contexts and ensure inclusivity.

This study acknowledges several limitations that must be considered when interpreting its findings. The relatively small sample of 48 participants, all from a single university in Iran, restricts the generalizability of the results to other populations and contexts. Future research with more extensive and diverse samples encompassing different age groups, educational backgrounds, and nationalities is recommended to enhance the external validity of similar studies.

Furthermore, the study was conducted within a specific cultural and educational context in Iran, which may have influenced participants' perceptions and experiences with Duolingo. Therefore, caution is necessary when applying these findings to populations or settings with different cultural backgrounds and educational systems.

The duration of the intervention and data collection, spanning only a single university semester, might also limit the observed effects. To better understand the sustained impact of Duolingo, future studies with longer durations, spanning multiple semesters or academic years, are recommended. Additionally, the study relied on self-reported measures for language learning achievement and self-regulated learning, which were susceptible to biases such as social desirability. While qualitative data were collected through interviews, solely relying on participants' perspectives might introduce other biases and potentially overlook the full range of experiences.

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#### **Appendix:** Interview questions

1. Describe your experience with Duolingo for learning French. What are your motivations, perceived benefits, and encountered challenges?
2. How has Duolingo impacted your French language skills in areas like vocabulary, grammar, listening, or speaking?
3. How do you use Duolingo to set goals, maintain motivation, and potentially utilize other resources alongside it?
4. What aspects of Duolingo do you find most/least helpful for French learning? Are there important aspects not addressed by the app?
5. What changes or features would you recommend to enhance your learning experience with Duolingo?