The Impact of Chatbot-Supported Self-Regulation Learning Strategies on Second Language Writing

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ABSTRACT

This study investigates the impact of a chatbot-supported self-regulated writing program (CSRW) on complexity, accuracy, and fluency (CAF) in second language (L2) writing. Additionally, the strengths and weaknesses of the program were identified based on participants' experiences. The research involved an experimental group of 30 learners from various nationalities studying Turkish as a second language, who engaged with the CSRW program, and a control group of 30 learners receiving traditional instruction. The CSRW program, delivered through ChatGPT, featured interactive writing tasks, personalised feedback, and self-regulation (SRL) strategies. Pre-tests and post-tests were conducted to measure changes. Findings revealed that the experimental group demonstrated significantly greater improvement in L2 writing complexity, accuracy, and fluency compared to the control group. Participants from the experimental group noted that the CSRW was beneficial for fostering learner autonomy. These findings indicate that CSRW enhances L2 writing performance and learner self-regulation. The study contributes insights aligned with existing literature while offering novel perspectives that may inform future research.

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Introduction

Recent advances in artificial intelligence (AI) technology have fostered the adoption of certain innovations in the field of language education (Wang, Zhu & Zhang, 2023; Shin et al., 2021; Fathi et al., 2024). Specifically, chatbots, a product of AI technology, offer various opportunities for language learning. Consequently, empirical studies on using AI-based chatbots to enhance the language skills of second language (L2) learners are rapidly expanding. In their meta-analysis, Wu & Li (2024) concluded that chatbots could effectively facilitate L2 skills development. Chatbots can provide immediate feedback in written and spoken communication, helping learners improve their language skills (Imran & Almusharraf, 2023; Özçelik & Ekşi, 2024). Research in this area has focused on enhancing speaking, writing, vocabulary, and grammar skills through chatbots (Maden & Yetişensoy, 2024). Findings show that this technology particularly supports writing and speaking skills, while also increasing motivation to learn a language (Alrajhi, 2024; Fathi et al., 2024). As a result, researchers are increasingly focusing on the role of chatbots in facilitating speaking and writing practices in language learning. Alrajhi (2024) observed that chatbots enhance writing skills and alleviate writing anxiety, although some limitations are also noted. For instance, chatbots may be overly sensitive to grammatical errors, and the lack of human interaction elements has caused some students to lose motivation (Alrajhi, 2024).

Unlike native language acquisition, which occurs within an authentic social context, L2 learning often requires conscious effort. Thus, individuals must employ strategies such as setting learning goals, planning, and monitoring their progress (Pintrich, 2004; Oxford, 2011). At this point, the importance of self-regulated (SRL) learning becomes evident, as L2 learning is a long-term endeavor. Those with SRL skills can manage their language learning process more effectively (Schunk & Zimmerman, 1994) and maintain their motivation despite challenges (Zhou & Hiver, 2022). According to Zimmerman (2000), SR is the capacity to control one's own learning processes, which is a critical factor for success. From this perspective, when language learners enhance their SR skills, they are likely to achieve greater success in their language learning journey.

Self-regulated Learning

SRL strategies include techniques such as time management, organizing learning materials, seeking feedback, and self-assessment (Chang, Lin, Hajian & Wang, 2023). Oxford (2011) emphasizes that SRL has a significant impact on intrinsic motivation in L2 learning. Learners who set their own goals and manage their journey toward achieving these goals become less reliant on external factors, leading to a more sustained and enduring learning process. Similarly, learners using chatbots can create their own learning schedules and even develop authentic contexts through dialogues generated with chatbots (Xiao, Zhang & He, 2024). Through this process, learners can identify their strengths and weaknesses in the target language and create personalized learning programs with AI (Dörnyei, 2005). Pintrich (2004) documents another advantage of SRL, noting that developing SRL skills contributes not only to academic achievement in language learning

but also to problem-solving and critical thinking abilities. Ultimately, self-regulation skills in L2 learning can foster greater independence and make the language learning process more efficient. The outcomes of having self-regulation skills and effectively using chatbots for language learning appear to be closely related.

Chatbots in Second Language Learning

Studies on the use of chatbots in L2 learning have primarily focused on writing and emphasized its suitability for skill development (Ji, Han, & Ko, 2023; Maden & Yetişensoy, 2024). Therefore, investigating the effects of chatbot-supported SRL on writing skills in L2 learning could yield valuable insights. Numerous studies have explored chatbots and SRL in language education (Wang, Zhu & Zhang, 2023; Maden & Yetişensoy, 2024). chatbot-supported SRL has been examined in the context of reading (Pan, Guo & Lai, 2024) and speaking (Zang, 2024; Qiao, 2023) in L2 learning. However, the outcomes of chatbot-supported SRL on writing skills in L2 learning remain unexamined (Wu & Li, 2024). The integration of AI-supported language learning and self-regulated learning provides a relevant framework for examining L2 writing development.

Recent research has continued to deepen the understanding of AI chatbot–supported second language (L2) learning processes. In the context of writing, studies have shown that individualized and interactive feedback through AI chatbots enhances learners' writing quality, engagement, and motivation (Deep et al., 2025), while also supporting self-regulated learning processes (Guan et al., 2025). Li et al. (2025) examined the same phenomenon through the lens of Activity Theory, concluding that chatbot-supported language learning produces four types of learning outcomes—cognitive, affective, behavioral, and agentic—and that teacher–AI collaboration plays a crucial role in realizing these gains.

The contribution of chatbot use to the development of AI literacy in second-language writing has also been highlighted by Wang and Wang (2025). Their findings indicate that in AI-mediated learning environments, learners employ chatbots as tools for planning, implementing, and evaluating their own learning strategies. Through this process, learners critically engage in the self-regulation cycle during writing tasks. Similarly, Mekheimer (2025) investigated the effects of AI-assisted writing feedback on students learning English as a foreign language and found significant improvements in semantic coherence, linguistic accuracy, and revision quality. Immediate feedback provided by AI accelerated students' ability to identify and correct errors and to reconstruct their written texts more effectively.

Evaluation Of Writing Outputs in Language Learning

Several approaches have been proposed to evaluate learners' writing performance. One of these is the Complexity, Accuracy, and Fluency (CAF) framework. The CAF framework, widely used in second language research, provides a multidimensional model for analyzing L2 writing performance. CAF evaluates language performance across three dimensions, with each dimension assessed according to specific features (Chang et al., 2023). Consequently, analysing L2 writing performance in terms of complexity, accuracy,

and fluency provides a robust foundation for understanding developments in writing skills.

Pallotti (2009) proposes complexity, fluency, and accuracy as essential criteria for understanding language performance, emphasizing that these elements should also be compared with other performance aspects, such as language development or communicative competence. The CAF framework is widely acknowledged as a powerful approach for evaluating both native and L2 learning.

Complexity in language use refers to sophistication and structural variety. Pallotti (2009) demonstrates that this dimension can be subdivided into syntactic (sentence structure) and lexical (word variety) complexity. Complexity measures focus on the range and diversity of structures that a student can utilize (Skehan, 1998).

Accuracy assesses the extent to which language use conforms to grammatical rules (Pallotti, 2009). This dimension evaluates how closely linguistic output aligns with the norms of the target language, measured through indicators such as error rates and proportions of correct structures. In writing, accuracy requires adhering to rules of grammar, word choice, and punctuation (Ellis, 2009).

According to Pallotti (2009), fluency reflects the capacity for speed and continuity in language use, focusing on the ability to produce language without hesitation. It is measured by criteria such as words produced per unit of time or instances of pauses. Skehan (2009) defines writing fluency through three main sub-dimensions of linguistic productivity: speed, which refers to the number of words or sentences produced per unit time; interruptions, indicating the frequency, length, and location of pauses; and repair, referring to the frequency of false starts, corrections, and repetitions in the text.

Compared to other skills, writing demands more conscious thought and attention, as well as a more detailed knowledge and application of language rules (Hyland, 2003). Thus, effective strategies may be even more necessary for developing writing skills. Second language (L2) acquisition often intensifies beyond school age, underscoring the growing importance of lifelong learning strategies (Gouthro, 2022). In this context, self-regulated learning (SRL), where individuals actively manage their learning processes, has emerged as a prominent approach. SRL includes strategies that enable students to take an active role in setting learning goals, selecting appropriate strategies, and evaluating their progress (Zimmerman, 2002; Pintrich, 2000). SRL is generally composed of three elements: cognitive, motivational, and behavioural components (Boekaerts, 1997; Schunk & Zimmerman, 1994). The cognitive component involves information processing skills and problem-solving strategies, while the motivational component reflects students' interest and effort in the learning process (Schunk & Zimmerman, 1994). The behavioural component, on the other hand, assists students in structuring their environment and optimising study conditions (Zimmerman, 2000). SRL strategies encompass a range of sub-skills, including the ability to observe, assess, and adapt one's learning processes. Zimmerman (2002) describes SRL as a cyclical process, where students continuously engage in planning, monitoring, and evaluating to improve their learning. The first phase, planning, involves setting learning objectives and selecting suitable strategies (Pintrich, 2000). The monitoring phase requires students to observe their progress towards their goals, adjusting as needed (Boekaerts, 1997). Finally, the evaluation phase enables

students to analyse their performance and develop more effective strategies for future learning (Schunk & Zimmerman, 1994). In the context of the global shift towards online learning during and after the COVID-19 pandemic, the need for self-regulation and digital tools has become increasingly significant. For language learning, meeting these needs is particularly critical. Wang, Zhu, and Zhang (2023) highlight the role of computer-assisted language learning and artificial intelligence (AI) in enhancing students' self-regulation skills. Especially in the post-pandemic era, chatbots used in online education have had a positive impact on language learning motivation and SRL (Wang, Zhu, & Zhang, 2023). AI-based chatbots are now widely recognised for their potential in language education, as they offer an interactive and personalised environment conducive to developing writing skills. For example, chatbots allow students to engage in real-time dialogues, providing language practice free from the fear of making mistakes and the limitations often associated with communicating with real people (Fryer & Carpenter, 2020).

The possibilities offered by chatbots for language learning are well-established. Over two decades ago, Jia (2004) found promising results on the interactive learning opportunities chatbots provide. Chatbots offer immediate feedback on grammar and word choice, and as Kwon, Shin, and Lee (2023) suggest, they encourage students to use accurate language structures. This type of interaction, paced to suit the learner, can build confidence and ultimately lead to fluent writing over time (Du & Daniel, 2024). In alignment with these perspectives, Chang et al. (2023) developed an AI-based chatbot design to support SRL in educational settings. Our study focuses on the use of SRL strategies, supported by AI, to enhance L2 writing skills demostrated by Chang et al. (2023) and Zileli (2024).

Chang et al. (2023) proposes a three-step model:

1. Review of Educational Principles: Examining how AI-based chatbots can support writing skills.

2. Focus on the SRL Process: Creating writing tasks and learning principles in line with SRL principles.

3. User Interface Research: Conducting a comparison to select ChatGPT 4.0 as the preferred platform.

In a recent study, Zileli (2024) explored the application of ChatGPT for learning Turkish as a second language, providing insights on using ChatGPT for dialogue practice, word meaning, text translation, feedback, and writing across various contexts. Further details on the learning process are provided in the "Learning Process and Participants" section.

AI chatbots have been increasingly used and researched in second language writing. Writing which requires higher levels of planning, monitoring, and self-correction, has received limited attention. Moreover, the integration of self-regulated learning strategies into chatbot-supported writing has not been empirically examined. Therefore, there is a clear gap in the literature regarding how chatbot-supported self-regulation affects the complexity, accuracy, and fluency of second language writing, particularly in the context of learning Turkish as a second language.

This study aimed to examine the effects of chatbot-supported SR Writing learning (CSRW) on L2 writing skills. Writing outputs were analysed. in terms of fluency, accuracy, and complexity before and after the CSRW program as an experimental intervention. Additionally, comprehensive data were gathered regarding participants' views on their learning experiences. The results of this research are expected to provide new perspectives in the literature on chatbot-supported language learning, while contributing pedagogical insights for improving writing skills in L2.

Based on the purpose of the study, the following research questions were formulated:

RQ1. To what extent does the Chatbot-Supported Self-Regulated Writing (CSRW) program improve the writing accuracy of L2 learners?

RQ2. To what extent does the CSRW program enhance the writing complexity of L2 learners?

RQ3. To what extent does the CSRW program increase the writing fluency of L2 learners?

RQ4. What are the learners' perceptions of the CSRW program regarding its effectiveness in improving L2 writing skills?

Methodology

Research Design

The participants of the study consisted of individuals learning Turkish as a second language. This study aimed to investigate the impact of the Chatbot-Supported Self-Regulated Writing (CSRW) Program on these learners' writing skills.

For the CSRW Program, we have incorporated steps demonstrated by Chang et al. (2023) and Zileli (2024).

Figure 1. Educational Principles, SRL, and Directionality

Note. Adapted from Chang et al. (2023, p. 12).

An experimental pre-test and post-test design with control and experimental groups was employed. In the first phase of the study, both groups completed a pre-test writing task, which was analysed for accuracy, complexity, and fluency. In the second phase, the experimental group participated in the CSRW Program for seven weeks, while the control group completed traditional writing assignments. At the end of the program, both groups completed a post-test with the same writing task, and the outputs were analysed. Quantitative data from pre- and post-test measurements were compared, and qualitative data were gathered by examining the experimental group's experiences with the CSRW

Program. By combining quantitative and qualitative approaches, the study follows a mixed-methods design. Mixed methods offer a more in-depth understanding by integrating both types of data collection and analysis (Creswell, 2014). The study adopts an explanatory sequential design, where quantitative data is collected and analysed first, followed by qualitative data collection to explain these findings (Creswell, 2014; Clark & Ivankova, 2016; Tashakkori & Teddlie, 2010).

Publication Ethics

This study was approved by the Social and Human Sciences Research and Publication Ethics Committee of Alanya Alaaddin Keykubat University (Approval No: 26, Date: 4.12.2024).

Participants

The participants consisted of 60 A2-level students learning Turkish as an L2 in Antalya, Türkiye, selected through purposive sampling to target individuals with specific knowledge relevant to the study (Patton, 2002). Thirty students were assigned to the experimental group, and thirty to the control group, with language proficiency equivalency ensured through the standardized Turkish Proficiency Test.

Table 1. Participant information

		Experimental		Control	
		N	%	N	%
Sex	Female	18	61	16	54
	Male	12	39	14	46
Status	International student	17	57	19	64
	Resident foreigner	13	43	11	36
	20-24	11	37	13	42
	25-29	11	37	7	24
Age	30-34	4	13	6	20
	35-39	-	0	2	7
	40-44	3	10	2	7
	45+	1	3	-	0
	Russia	10	33	8	27
Nationality	Iran	5	17	10	33
	Ukraine	5	17	1	3
	Kazakhstan	7	24	5	17
	İndia	-	0	1	3
	Syria	1	3	5	17
	Canada	1	3	-	0
	England	1	3	-	0
Total		30	100	30	100

A CSRW was prepared for the experimental group, consisting of principles and writing tasks designed to integrate self-regulation strategies with chatbot interaction (Chang et al., 2023). The program outlines 14 tasks over seven weeks, with each week including detailed guidelines and expectations for writing tasks

Data Collection and Analysis

Complexity, Accuracy, and Fluency (CAF) Scale

A writing assessment scale (WE) was developed based on a framework to assess text complexity, accuracy, and fluency (CAF), commonly used in second language acquisition studies (Skehan, 1998; Housen, Kuiken, & Vedder, 2012; Pallotti, 2009). According to Pallotti (2009), the measurement of fluency, accuracy, and complexity provides a multidimensional framework for evaluating language performance. This approach, commonly referred to as CAF, is widely used in second language acquisition studies and enables researchers to quantify language proficiency across these three dimensions. Each dimension is defined as follows, with corresponding measurement formulas suggested by Pallotti:

Complexity examines the sophistication of linguistic structures used in language production. It is often operationalized by calculating the ratio of subordinate clauses to total clauses, reflecting the ability to produce complex, embedded structures. Higher use of subordinate clauses correlates with greater syntactic complexity, and the formula is as follows:

Complexity = Number of subordinate clauses ÷ Total number of clauses × 100

Accuracy reflects the degree to which language use adheres to grammatical norms and target-like structures. Accuracy is commonly assessed by calculating the proportion of grammatically correct utterances relative to total language output. This measurement underscores the accuracy of linguistic production, with fewer errors indicating higher accuracy. The formula used is:

Accuracy = Number of correct structures ÷ Total number of structures X 100

Fluency is characterized by the learner's ability to produce language at a natural rate, emphasizing speed and continuity. In writing assessments, fluency can be quantified by measuring the total number of correct words produced over a specified period. A higher word count in the same amount of time indicates greater fluency.

Fluency = Total Correct Word Count ÷ Writing Time (Minutes)

Interview Form (IF)

Semi-structured interviews were conducted with the experimental group participants to gather qualitative data on their experiences with the *CSRW Program* (Chatbot-Supported Self-Regulated Writing Program). The interview form allowed for structured questions while enabling flexible responses, striking a balance between systematic inquiry and the participants' freedom to share their unique perspectives (Kvale, 1996). The interviews lasted between 15 and 30 minutes and focused on participants' experiences of developing Turkish writing skills through the CSRW Program. Specific attention was given to their use of ChatGPT 4.0 for writing exercises, receiving feedback, and applying self-regulation strategies to enhance their writing fluency and accuracy.

Sample questions included: *How did using ChatGPT 4.0 affect your writing skills in Turkish? Which self-regulation strategies did you find most useful during the program? What challenges did you face while using the CSRW Program to improve your writing?"*

The development of the form involved the following stages: Firstly, draft questions were prepared based on research on self-regulated learning (Zimmerman, 2000; Zimmerman, 2002) and second language writing (Ellis, 2009; Teng, 2022). Secondly, two field experts reviewed the questions to ensure alignment with the study's objectives and relevance to participants' experiences. Thirdly, IF was piloted with three participants from the target group, leading to minor revisions to improve clarity and depth.

For the quantitative analysis, normality of the CAF data distribution was assessed using the Kolmogorov-Smirnov test and skewness-kurtosis values.

Table 2. Kolmogorov-Smirnov tests for CAF

			N	p	Skewness	Kurtosis
Experimental	Fluency	Pre-Test	30	0.00	0.75	0.75
		Post-Test	30	0.61	0.04	-1.24
	Accuracy	Pre-Test	30	0.00	0.75	0.75
		Post-Test	30	0.80	0.10	-0.63
	Complexity	Pre-Test	30	0.00	0.06	0.75
		Post-Test	30	0.00	-0.98	0.44
Control	Fluency	Pre-Test	30	0.00	0.75	0.75
		Post-Test	30	0.47	0.11	-1.28
	Accuracy	Pre-Test	30	0.00	0.75	0.75
		Post-Test	30	0.00	0.91	-0.04
	Complexity	Pre-Test	30	0.00	0.75	0.75
		Post-Test	30	0.23	-0.18	-1.24

Table 2 displays Kolmogorov-Smirnov test results, skewness, and kurtosis values for pre- and post-test scores of the CAF scale. Values within the ±2 range indicate normal distribution (Tabachnick & Fidell, 2019). Based on this, parametric statistical tests were used to compare the pre-test and post-test scores, including paired sample t-tests to assess significant differences (Field, 2013). The qualitative data obtained from the SIF were analysed using content analysis, as outlined by Creswell (2014). This involved reducing, organizing, and describing the data in phases: irrelevant content was removed, data were coded, and categories, sub-themes, and themes were established based on horizontal and vertical relationships among the codes.

Procedure

This study was carried out over an eight-week period at the Turkish and Foreign Languages Research and Application Centre (ALKÜ TÖMER) during the Fall semester of the 2023–2024 academic year. The participants were adult learners enrolled in a B1-level Turkish as a foreign language program. All participants were students from various linguistic and cultural backgrounds who were learning Turkish as a second language (L2).

Participants were then randomly assigned to either the experimental group (chatbot-supported self-regulated learning) or the control group (traditional instruction). Both groups received the same course content and writing assignments, but the experimental group had access to a chatbot tool (ChatGPT) designed to support the development of self-regulated learning (SRL) strategies such as goal setting, self-monitoring, seeking feedback, and self-reflection.

The chatbot was integrated into the students' weekly writing tasks through guided

prompts and structured activities. For instance, students in the experimental group used the chatbot to brainstorm ideas, outline their arguments, and revise their texts. The chatbot also provided tailored feedback and reflective questions aimed at fostering metacognitive awareness and strategic planning.

The program was integrated into students' regular writing classes rather than being a separate course. Each week, two writing sessions were held, during which ChatGPT assisted students in setting goals, generating ideas, reviewing their texts, and conducting self-assessment. Writing activities were designed to promote metacognitive awareness and learner autonomy, encouraging participants to go beyond grammatical accuracy to achieve fluency, coherence, and meaningful expression.

Table 3. Program

Week	Writing Theme	Linguistic Focus	Self-Regulation Strategy
1	Daily Life and Time Management	Verb conjugations, time adverbs,	Goal setting
2	Healthy Living and Habits	Imperatives, frequency adverbs, cause–effect connectors	Self-monitoring, feedback seeking
3	Holidays and Travel Experiences	Past tense, sequencing, descriptive language	Plan revision, self-evaluation
4	Education and Learning Experiences	Idiomatic expressions, mood usage, cohesion	Strategic writing, reflection
5	Technology and Daily Life	Causative structures, word formation	Problem solving, metacognitive awareness
6	Culture, Traditions, and Celebrations	Comparative structures, contrastive conjunctions	Planning, self-assessment
7	Future and Dreams	conditional mood, text coherence	Independent revision

A three-stage self-regulated writing cycle was followed each week:

1.Planning and Goal Setting: Students reviewed feedback from previous weeks and set specific weekly goals (e.g., "I will use conjunctions more accurately" or "I will write longer and more cohesive sentences").

2.Writing and ChatGPT Interaction: During writing, students used ChatGPT as a reflective and guiding partner to develop ideas, improve linguistic accuracy, and enhance text coherence. The chatbot provided metacognitive prompts such as *"Can you support this idea with an example?"* or *"How could you make this paragraph clearer?"* to help learners monitor their progress.

3. Reflection and Self-Evaluation: After completing each task, students filled out a short reflection form to evaluate their texts in terms of fluency, accuracy, and complexity, and to comment on the usefulness of ChatGPT's feedback.

Weekly writing themes were directly linked to the *Yeni İstanbul B1* units, allowing students to express opinions, describe experiences, and reflect on real-life situations. At the end of the program, all writing outputs and reflection forms were analysed qualitatively. The findings indicated that learners showed substantial progress in text

planning, cohesion, and independent revision, demonstrating increased self-regulation and confidence in L2 Turkish writing.

Data were collected through pre- and post-tests, SRL strategy questionnaires, weekly reflections, and the final writing products. Quantitative data were analysed using SPSS to compare improvements in writing performance between the groups, while qualitative data were coded thematically to identify patterns in SRL behaviours.

Results

The conceptual relationships derived from the content analysis of participants' experiences and perspectives regarding Chatbot-Supported Self-Regulation in Writing (CSRW) are presented in Figure 2.

Figure 2. Content analysis
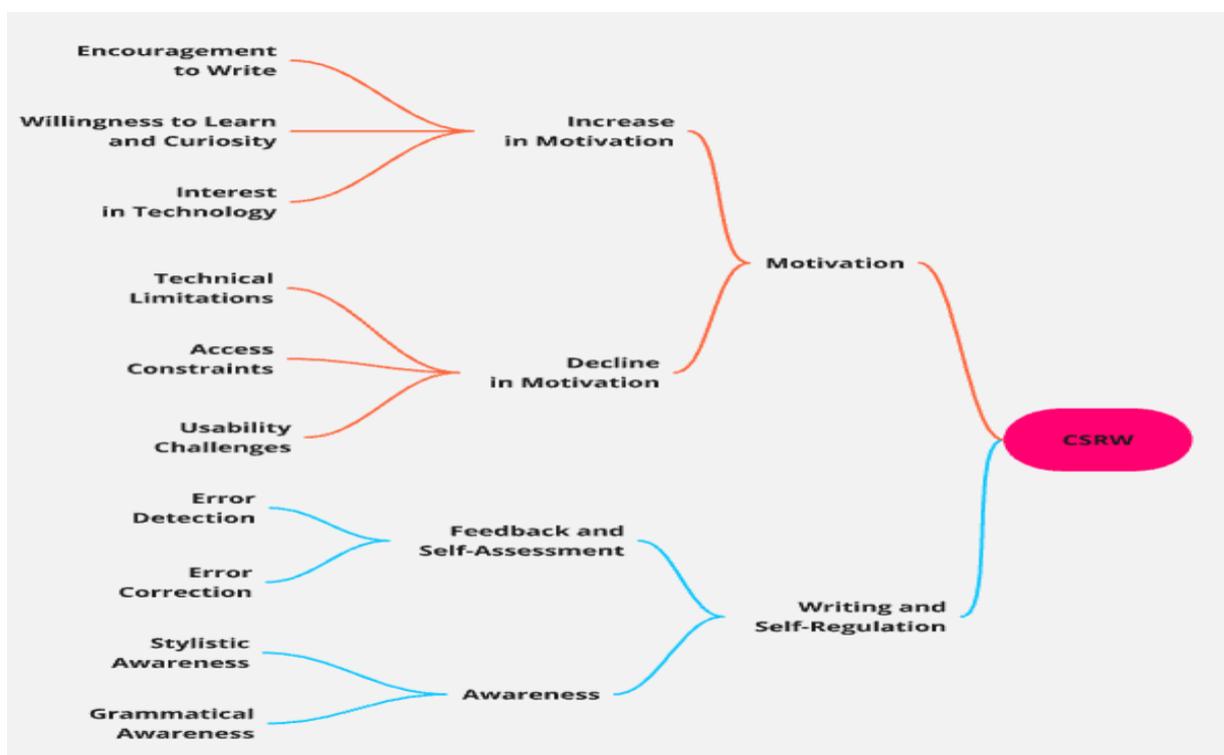
The effects of the CSRW program were tested in terms of writing complexity, accuracy, and fluency, and the findings were supported by participants' perspectives.

Chatbot-Supported SRL Writing Program and Complexity

The T-test results examining the effect of chatbot-assisted self-regulation strategies on writing complexity are presented in Table 3. The analysis compares pre-test and post-test scores to determine any significant differences in writing complexity attributable to the intervention.

Table 3. The T-test for the effect of chatbot-assisted self-regulation strategies on writing complexity

		N	M (SD)	t (df)	p	Cohen's d
Experimental	Pre-Test	30	66 (8.13)	-3.7 (58)	.00	0.97.
	Post-Test	30	75.1 (10.18)			
Control	Pre-Test	30	65.7 (8.4.)	-0.82 (58)	.41	0.21.
	Post-Test	30	68.6 (8.9)			

In Table 3, the effect of the Chatbot-Supported SRL Writing (CSRW) program on writing complexity is analysed. In the control group, there was no statistically significant difference between the pre-test (M = 65.7, SD = 8.4) and post-test (M = 68.6, SD = 8.9) scores (t = −0.82, p = 0.41), with a small effect size (d = 0.21). However, in the experimental group, a significant increase was observed from the pre-test (M = 66, SD = 8.13) to the post-test (M = 75.1, SD = 10.18) (t = −3.7, p = 0.00), with a large effect size (d = 0.97). This indicates that CSRW enhanced syntactic complexity, reflected in increased structural variety. Participants also reported that the CSRW program helped them develop self-assessment skills, as reflected in the sub-themes of error recognition, correction, and grammatical improvement.

"I quickly noticed where my mistakes were and corrected them." (S3)
"I learned from my mistakes and tried to write correctly next time." (S7)

These findings may contribute that CSRW improved participants' ability to use language structures accurately in their L2.

Chatbot-Supported SRL Writing Program and Accuracy

Table 4. The T-test for the effect of chatbot-assisted self-regulation strategies on writing accuracy

		N	M (SD)	t (df)	p	Cohen's d
Experimental	Pre-Test	30	64.7 (8.48)	-2.16 (58)	0.03	0.56.
	Post-Test	30	69.4 (8.43)			
Control	Pre-Test	30	64.4 (8.9)	-0.60 (58)	0.54	0.16
	Post-Test	30	66.8 (8.3)			

Table 4 presents the results of the T-test examining the effect of chatbot-assisted self-regulation strategies on writing accuracy. This analysis compares the pre-test and post-test scores to assess any significant differences in writing accuracy resulting from the intervention. In the control group, there was no significant difference between the pre-test (M = 64.4, SD = 8.9) and post-test (M = 66.8, SD = 8.3) scores (t = −0.60, p = 0.54), with a small effect size (d = 0.16). Conversely, in the experimental group, there was a significant increase in accuracy scores from the pre-test (M = 64.7, SD = 8.48) to the post-test (M = 69.4, SD = 8.43) (t = −2.16, p = 0.03), with a medium effect size (d = 0.56). This reveals that CSRW has a moderate effect on improving writing accuracy. Participant feedback, categorized under "Awareness," supports these findings, with many participants noting improvements in writing style and grammar awareness.

"The feedback from ChatGPT helped me see what to focus on in my writing." (S8)

Chatbot-Supported SRL Writing Program and Fluency

As shown in Table 5, the CSRW program's impact on writing fluency was

analysed.

Table 5. The T-test for the effect of chatbot-assisted self-regulation strategies on writing fluency

		N	M (SD)	t	p	Cohen's d
Experimental	Pre-Test	30	3.1 (0.34)	-3.28	0.00	0.85
	Post-Test	30	3.41 (0.31)			
Control	Pre-Test	30	3.13 (0.39)	-0.94	0.34	0.24
	Post-Test	30	3.23 (0.47)			

In the control group, there was no significant difference between the pre-test (M = 3.13, SD = 0.39) and post-test (M = 3.23, SD = 0.47) scores (t = −0.94, p = 0.34), with a small effect size (d = 0.24). However, in the experimental group, a significant increase in fluency was observed from the pre-test (M = 3.1, SD = 0.34) to the post-test (M = 3.41, SD = 0.31) (t = −3.28, p = 0.00), with a large effect size (d = 0.85). The results shows that CSRW significantly enhances writing fluency.

Participants' Views on the Chatbot-Supported SRL Writing Program

This section presents participants' perspectives on the CSRW program, focusing on their experiences in writing, responses to feedback, and developments in self-regulation skills. The sub-sections outline participants' reflections and observations regarding their engagement with CSRW.

1. Writing and Self-Regulation (SR): Participants reported that feedback provided by ChatGPT played a significant role in enhancing their self-regulation skills throughout the writing process. This feedback helped them in recognising errors, correcting mistakes, and developing awareness in writing style and grammar.

1.1. Feedback and Self-Assessment: Participants found ChatGPT's feedback beneficial for quickly identifying and understanding their writing errors, providing strong encouragement for writing correctly.

"ChatGPT pointed out my mistakes and corrected me." (S1)

"The feedback helped me understand my mistakes, encouraging me to write correctly." (S4)

1.1.1. Recognising Errors: Through feedback, participants took a more active role in identifying and understanding their errors, which led to increased engagement in the writing process.

"I corrected the areas that ChatGPT highlighted and improved my writing." (S5)

"I tried to fix my mistakes based on the feedback." (S6)

1.2. Awareness: Participants reported greater awareness in both writing style and grammar because of ChatGPT's feedback, helping them adopt a more mindful approach to language use.

1.2.1. Stylistic Awareness: The feedback allowed participants to gain better insight into the strengths and weaknesses of their writing style, guiding them towards self-improvement in stylistic areas.

"ChatGPT's analyses helped me understand my shortcomings." (S10)

"I saw better ways to improve my writing through feedback." (S3)

1.2.2. Grammar Awareness: ChatGPT prompted participants to pay closer attention to grammatical rules, supporting a more conscious approach to language use.

"I improved my grammar and writing." (S9)

2. Motivation: The feedback received from ChatGPT was observed to enhance participants' motivation to write, with many reporting an increased eagerness towards the Turkish language learning process.

2.1. Increase in Motivation

2.1.1. Encouragement to Write: ChatGPT's feedback encouraged participants to write more, increasing their confidence in their Turkish writing abilities.

"I feel more confident writing in Turkish after this program." (S6)

"Seeing and correcting my mistakes encouraged me to write more." (S3)

2.1.2. Interest and Curiosity in Learning: Participants highlighted that the CSRW program stimulated their interest and curiosity in learning Turkish, reflecting the motivational impact of the program.

"I looked forward to seeing the feedback." (S2)

"I'm more motivated to learn Turkish." (S7)

2.2. Decrease in Motivation: Some participants showed that technical limitations sometimes led to a decrease in motivation.

2.2.1. Technical Limitations: Participants encountered challenges with certain technical aspects of ChatGPT, which they felt hindered their learning experience.

"I couldn't fully use ChatGPT due to technical issues." (S2)

2.2.2. Accessibility Challenges: A portion of participants (20%) could not complete some of the tasks because they were unable to access the premium version of ChatGPT.

"I have a Russian credit card, so I didn't use the premium version and couldn't complete every task." (S10)

"I didn't use the premium ChatGPT version, so I only completed part of the tasks." (S7)

2.2.3. Difficulty of Use: Some participants found it challenging to adapt to certain features of ChatGPT, which impacted their initial engagement with the platform.

"It took time to learn how to use the application." (S10)

"I struggled to fully understand some functions." (S8)1.

The findings of the study demonstrate that three out of four hypotheses are supported, while one hypothesis is largely supported based on participants' experiences and statistical evidence.

Discussion

This study investigated the impact of the Chatbot-Supported SRL Writing Program (CSRW) on writing complexity, accuracy, and fluency in a second language. The findings indicate that CSRW positively influences these aspects, supporting other studies exploring

chatbot-supported self-regulated learning in various language skills.

Guan, Raković, Chen, and Gašević's (2024) meta-analysis revealed that chatbots significantly support students in identifying learning resources, applying appropriate learning strategies, and monitoring their studies metacognitively. Zhou and Hiver (2022) found that using self-regulation strategies in L2 writing processes is a crucial predictor of students' engagement in writing classes and reduces procrastination behaviours in L2 writing. Arhin (2024) explored how learners of Russian as a foreign language perceive ChatGPT as a learning tool, with findings highlighting its impact on learning autonomy—a concept closely related to SRL. Arhin (2024) also investigated ChatGPT use within the ethical framework, finding that it positively affects learners' autonomy and responsible usage in learning Russian. In this context, "responsible use" means avoiding ChatGPT for cheating or misrepresentation, instead utilizing it to genuinely enhance learning. Based on these findings, both AI-based chatbot technology and self-regulation strategies were employed in developing L2 writing skills.

Focusing on writing development, Wei, Wang, and Dong's (2023) study is noteworthy for examining Grammarly, an AI-supported writing evaluation tool, and its effect on writing task performance. The results indicate positive impacts on various aspects of writing skills, such as coherence, vocabulary usage, and grammatical accuracy. Furthermore, students in the experimental group demonstrated higher L2 motivation and used more self-regulation strategies. Our study took this a step further, suggesting that L2 writing skills could develop in terms of complexity, accuracy, and fluency through similar approaches, a claim supported by our findings. From a comparable perspective, researchers such as Zhang (2024), who employed Google Assistant, Qiao and Zhao (2023), who utilized Duolingo, and Alrajhi (2024), who used Tutor Mike, have applied similar procedures to the speaking skill domain. These studies consistently showed that chatbot-assisted self-regulation strategies enhanced L2 speaking proficiency, and increased language learning motivation. Collectively, these studies demonstrate the significant potential of chatbot-supported SRL in second language acquisition.

However, some limitations of chatbot-assisted writing instruction were identified. Wang, Aguilar, Bankard, Bui, and Nye (2024) examined university students' experiences with using AI in their writing processes. Students reported weaknesses such as a mechanical and impersonal tone, lack of personal voice, and insufficient critical thinking. Nevertheless, overall user attitudes toward AI tools remain positive (Arhin, 2024; Guan et al., 2024; Zhang, 2024; Qiao & Zhao, 2023; Alrajhi, 2024).

Studies investigating SRL applications supported by chatbots, particularly in terms of complexity, accuracy, and fluency (CAF), align with our research findings. For example, increasing the use of more complex linguistic structures in writing supports academic language proficiency. In this context, Zhang, Zou, and Cheng (2023) implemented a chatbot-based training program for EFL students focused on argument writing. Their results showed that chatbots could serve as effective tools in language teaching, especially in helping students learn logical coherence and enhance argumentative writing. This finding could potentially extend to L2 contexts, where the CSRW (Chatbot-Supported Writing Regulation) Program positively influenced writing complexity.

Specifically, our research suggests that CSRW Program is effective in improving L2 writing accuracy, as ChatGPT not only enhances accuracy but also provides valuable feedback (Mizumoto, Shintani, Sasaki, & Teng, 2024). This highlights the importance of AI-supported technologies in L2 writing assessment, necessitating further research and experimental studies in this area.

Özçelik and Ekşi (2024) investigated the role of ChatGPT in enhancing second language writing skills, specifically considering language register knowledge. Unlike the studies discussed, participants found ChatGPT beneficial for acquiring formal register knowledge, but less useful for informal writing. This indicates that current chatbots still struggle to emulate natural communication contexts, though it is likely that rapidly improving AI-based chatbots will soon achieve this level of contextual accuracy. Such advances may lead to chatbots becoming flawless tutors for enhancing writing skills, as well as other language skills, in the future.

Conclusion

These findings demonstrate that the chatbot-supported self-regulated writing (CSRW) program had a significant and positive impact on writing complexity, accuracy, and fluency in the experimental group. Particularly notable were the substantial effect sizes observed in complexity and fluency, highlighting the potential of such technological tools to enhance various dimensions of writing skills. The lack of significant improvement in the control group further suggests that this method offers an excellent alternative for learning L2 writing. Qualitative findings also support the CSRW program's effectiveness as a learning tool for participants. Self-regulation strategies improved participants' ability to detect and correct their writing errors. Feedback from ChatGPT, as a chatbot, boosted motivation and fostered confidence in using technology. However, certain technical challenges limited the program's effectiveness. These findings underscore CSRW's efficacy as a supportive tool in L2 learning. Our results, along with findings in the literature, reveal strong interconnections among concepts such as artificial intelligence, chatbots, self-regulated learning, learner autonomy, lifelong learning, and sustainable learning. Clarifying these interrelationships through both theoretical and experimental research is essential for understanding the evolving digital technologies and learning methodologies of the future.

This study was conducted with participants at the A2 level of second language proficiency. It is recommended that further research encompass all proficiency levels, as exploring the effects of CSRW at advanced (C) levels could yield particularly insightful findings. Additionally, diversifying and enriching the writing contexts and tasks could provide more comprehensive results. Investigating the potential of AI-supported chatbots in second language acquisition, particularly in relation to individualised learning, lifelong learning, and sustainable learning, would offer valuable functional insights.

Suggestions

Based on the findings of this research, the following suggestions are offered for educators, researchers, and curriculum designers in the field of L2 education.

Chatbot technologies like ChatGPT can facilitate self-regulated learning, especially in the context of writing in a less commonly taught language like Turkish. Educators in TÖMER and similar institutions can use chatbots as scaffolding tools rather than as direct content providers.

Writing tasks should be enriched with prompts that promote planning, monitoring, and revision. Teachers should ensure that chatbot activities support SRL processes, such as encouraging learners to set writing goals and reflect on their progress.

Learners may need orientation on how to use chatbot tools effectively and ethically. Training should focus on using chatbots critically and reflectively, especially when learners engage with a language that is not widely supported in AI tools.

Chatbots can serve as continuous learning companions beyond the classroom. Structured integration of chatbot tools can promote autonomous language learning habits by allowing learners to take initiative, make decisions about their learning, and self-evaluate their performance over time.

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