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Exploring the effectiveness of a multimodal self-regulated learning grammar module for middle school students

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ABSTRACT

This study examined the effect of a multimodal self-regulated learning grammar (MSRLG) module on improving grammatical competence and self-regulated learning (SRL) skills among middle school students in Beijing, China. Using a mixed-methods approach, the research involved 305 participants, including 265 students and 40 English teachers. Data was collected through quantitative questionnaires to measure students' grammar skills and perceptions of grammar instruction, and through qualitative interviews to explore teachers' views on SRL and multimodal teaching methods, as well as their experiences with the MSRLG module. The findings showed that students who used the MSRLG module improved both their grammatical competence and SRL skills. Both students and teachers gave positive feedback on the module, noting that it made grammar learning more engaging and better suited to individual needs. The study also found that the module's goals aligned well with students' learning needs, and teachers were willing to implement SRL and multimodal strategies in their classrooms. This research highlights the value of integrating SRL and multimodal methods in grammar education, suggesting that this approach can improve grammar learning and encourage students to take more responsibility for their learning.

1. Introduction

The increasing integration of self-regulated learning (SRL) and multimodal learning approaches in education has resulted in an increased demand for adaptive learning methodologies that are tailored to students' individual experiences and interests. The methodologies described by Azevedo et al. (2022) have demonstrated promise in enhancing learning results, specifically in the context of teaching grammar to junior high school students in China. The purpose of our study was to utilize this approach to improve students' grammatical confidence. We aimed to address the shortcomings of traditional grammar instruction, which relies mainly on teachers and is commonly used in the Chinese educational system (Hornberger and Link, 2012). This form of grammar training results in a careless comprehension of grammar and, because of the lack

of focus on self-regulated learning, prevents students from using language effectively in practical situations (Batstone and Ellis, 2009).

The development of the multimodal self-regulated learning grammar (MSRLG) module was a direct response to the situation. This module integrates classroom instruction with self-regulated learning activities guided by the teacher (Abdelhalim, 2024). This encompasses strategies that educators can employ to enhance the comprehension of grammar principles, such as visual aids and interactive games (Phengsuai and Suwanarak, 2020). Additionally, it involves providing students with activities that promote independent learning and facilitate the development of their grammatical skills (Dabbagh and Kitsantas, 2012).

Our research focused on improving the grammatical ability of middle school students in Beijing. The project assessed the module's efficacy in promoting the acquisition of grammatical skills, students' opinions on grammar education, and English teachers' preparedness and attitudes towards SRL and multimodal teaching. Furthermore, the objective was to examine the module's content and align its instructional implementations with students' grammatical progress to offer teachers

who may choose to use the MSRLG module a set of instructions for its application.

This research has profound consequences for MSRLG students, instructors, and educational policymakers. A significant number of participants gained extensive knowledge of grammar through their involvement and are likely to utilize MSRLG as a tool or reference in the future to further enhance their grammar learning endeavors and improve their comprehension of grammatical concepts.

This research offers teachers and their professional organizations a comprehensive understanding of teachers' varied attitudes toward SRL and the potential difficulties they may encounter when attempting to implement multimodal tools and practices, as exemplified in the MSRLG module. To provide recommendations for using the module and establish professional development programs for instructors to use the multiliteracies component of the MSRLG module in the future, it is essential to have the necessary knowledge. Furthermore, the research findings provide educational policymakers with evidence of the possible advantages of combining SRL and multimodal pedagogies in grammar teaching. This information has the potential to impact curricula and policy decisions.

2. Literature review

Multimodal self-regulated learning leverages various modes of representation, including visual, auditory, and kinesthetic elements, to enhance learners' control over their learning processes. Kesuma et al. (2020) conceptualized self-regulated learning through a triadic model comprising forethought, performance, and self-reflection stages. This framework encourages learners to set objectives, strategize, and draw on prior knowledge in the forethought stage; implement strategies and monitor progress during the performance stage; and reflect on outcomes to inform future learning efforts in the self-reflection stage. Lam (2015) highlighted the efficacy of multimodal self-regulated learning in bolstering EFL learners' reading comprehension, writing skills, metacognitive awareness, and motivation.

The discourse on grammar instruction within language education oscillates between form-focused and meaning-focused approaches. While form-focused instruction prioritizes the explicit teaching of grammar rules, meaning-focused instruction advocates exposure to meaningful language use to foster implicit grammatical understanding. Both strategies offer distinct benefits; form-focused approaches enhance grammatical accuracy and explicit knowledge (Khalifeh et al., 2023), whereas meaning-focused methods improve communicative proficiency and implicit grammar understanding (Dehqan et al., 2022). The ongoing debate reflects the complexity of optimizing grammar teaching to cater to diverse learning needs.

The proliferation of technology in language education presents both opportunities and challenges. Technological tools, including multimedia software and mobile devices, offer dynamic and interactive learning experiences, immediate feedback mechanisms such as automated writing evaluation (AWE) systems, and personalized learning paths through adaptive learning technologies (Shunkov et al., 2022). Despite these advantages, challenges such as digital literacy and the integration of technology into traditional educational frameworks persist. Concerns also arise regarding the potential sidelining of essential language learning elements, such as interpersonal interaction and communication, in tech-centric educational models (Liddicoat, 2020).

Research exploring the confluence of multimodal self-regulated learning and grammar instruction reveals positive outcomes. Chen et al. (2021a; 2021b) demonstrated the superiority of self-regulated learning software over traditional instruction in enhancing EFL learners' grammatical proficiency. Similarly, Kim et al. (2015) reported that learners exposed to multimodal grammar instruction exhibited significant improvements in grammar knowledge and writing performance compared with peers receiving conventional instruction. Furthermore, studies by Wang and Li (2022) highlighted the potential of mobile technology in facilitating multimodal pedagogy (MMP) in grammar learning, suggesting that MMP, especially when augmented by technology, can significantly benefit language education. Wong and Nunan (2011) also reported that technology-enhanced language learning encourages self-regulated learning behaviors, indicating that technological integration can increase both grammatical proficiency and self-regulatory capacity.

These studies collectively affirm the effectiveness of multimodal self-regulated learning and technology in language education, especially in grammar instruction. Thus, the study aims to assess the effectiveness of the multimodal self-regulated learning grammar teaching module. To achieve this, a mixed-methods approach was adopted, involving both quantitative and qualitative data collection.

3. Methodology

3.1. Participants and sampling

In this mixed-methods study, a comprehensive approach was taken to gather data through both questionnaires and interviews, employing a sample that captured a wide array of perspectives from the educational setting under investigation. The sample size of 305 participants was determined on the basis of considerations of statistical power and diversity of perspectives, ensuring the robustness of both quantitative and qualitative findings. The participants were randomly selected from middle schools in Beijing, ensuring a representative sample of students and teachers across different backgrounds. Specifically, a minimum of 200

participants was deemed necessary for the quantitative phase to ensure sufficient statistical power for generalizable results (Rashid et al., 2021), while an additional buffer was incorporated to account for any potential nonresponse or incomplete data.

The sample consisted of 265 middle school students and 40 English teachers from Beijing. This distribution ensured representation from key stakeholders in English language education, enabling a comprehensive exploration of the integration of technology in grammar instruction. To reduce potential biases further and ensure that the sample was representative, participants were selected randomly from a broad range of schools and backgrounds within Beijing. Additionally, demographic factors such as age, gender, and teaching experience were considered to ensure that a well-rounded sample reflected the broader population (Watkins, 2016).

Following the questionnaire phase, the study further refined its focus to conduct in-depth interviews with a select group of participants. This qualitative component involved a total of 13 participants from the groups of quantitative study samples, consisting of 3 English teachers and 10 middle school students. These participants were chosen on the basis of their demonstrated interest in the subject matter and their ability to engage deeply with the research questions during both the implementation and evaluation phases of the study. To control for biases in the interview process, participants were chosen to represent a cross-section of the larger sample, ensuring that variations in teaching experience, student performance levels, and attitudes toward technology integration were captured (Robinson, 2014). This targeted selection for the interviews was aimed at obtaining nuanced insights into the educational processes, enriching the study's findings with detailed personal experiences and perspectives on English language instruction and the role of technology within it.

3.2. Research design

This study adopted a mixed-methods approach, integrating diverse research methodologies to shape its design and execution. The initial phase involved conducting a needs analysis to capture the perceptions of students and teachers regarding the current state of grammar instruction. This comprehensive analysis utilized both quantitative and qualitative methods to delve into the needs of multimodal self-regulated learning (MSRL) and the development of a multimodal pedagogy framework. The study drew on the insights of Peeters and Vaidya (2016) to deepen the understanding of integrating multimodal strategies into grammar teaching effectively.

Following the needs analysis, the research shifted its focus towards the design and development of the MSRL grammar module, informed by the gathered insights. The design principles were influenced by the work of Lai et al. (2016) on self-regulated learning, providing a foundation for enhancing learners' self-regulatory capabilities. Additionally, the instructional strategies within the MSRL module were crafted with guidance from Brieger and Pohl's (2002) research on grammar teaching methodologies, ensuring the development of effective pedagogical approaches.

The third phase involved the evaluation of the implemented MSRL module through both qualitative and quantitative methods. This critical evaluation aimed to gauge the module's usability, student engagement, and efficacy in improving grammatical skills. The framework proposed by Hewings (1999) for evaluating educational interventions served as a benchmark for assessing the impact of the MSRL module on student grammatical proficiency.

The study concludes with the provision of actionable recommendations for teachers seeking to adopt the MSRL module to foster grammatical competence in their students. These recommendations were directly derived from the research findings, offering practical advice for implementation in the classroom without an overreliance on extensive scholarly literature. The intent was to equip teachers with straightforward, evidence-based strategies to enhance grammar teaching efficacy.

3.3. Questionnaire and interview script design

The questionnaire and interview script devised for this study were meticulously designed with inspiration from the research conducted by Peeters and Vaidya (2016) and Lai et al. (2016). These pivotal studies provided a foundational framework for formulating questions aimed at thoroughly examining the perspectives and experiences of both teachers and students regarding the teaching and learning of English grammar, the application of self-regulated learning strategies, and the integration of technology within educational settings. Importantly, while our questions were informed by these studies, they were specifically tailored and modified to align with the unique context of our research, ensuring relevance and applicability. The modifications were made to better capture the nuanced insights relevant to our study's objectives rather than replicating the original questions verbatim.

Table 1 outlines how questions from the cited scholarly works were adapted for use in our study, providing clarity on the evolution of each question. For this research, responses were collected via a 5-point Likert scale ranging from strongly negative to strongly positive. This scale was chosen to allow for a nuanced assessment of attitudes and experiences, facilitating a comprehensive analysis of the data collected from participants.

In addition, as shown in Table 2, the construction of the interview protocol was meticulously guided by the scholarly literature, leveraging the insights of eminent researchers to inform the creation of our questions while ensuring that they were finely tuned

to the specific exigencies and goals of our research inquiry. This deliberate method of adaptation preserved the methodological coherence and scholarly integrity of our investigation, simultaneously allowing us to draw upon the rich theoretical and empirical contributions of the field.

Table 1: Comparison of the references to the items used

Scholar's questions	This study's questions (modified)	Response options (1 point-5 points)
Q1. How often do you use technology in the classroom?	Q1. How frequently do you engage in grammar tasks outside of class?	Never - always
Q2. How confident are you in using technology for teaching/learning?	Q2. How would you rate your ability to understand and apply English grammar?	Very unconfident - very confident
Q3. How often do you use self-regulated learning strategies when using technology for teaching/learning?	Q3. How often do you employ self-directed learning strategies for studying English grammar?	Never - always
Q4. How effective do you think technology is in enhancing your teaching/learning experience?	Q4. How would you rate the effectiveness of self-regulated learning strategies in learning English grammar?	Not Effective at all - very effective
Q5. How often does your teacher/mentor give you feedback on your performance in using technology for learning?	Q5. How frequently does your English teacher provide feedback on your grammatical accuracy?	Never - always
Q6. What type of feedback do you find most helpful in using technology for learning?	Q6. How helpful do you find the feedback on your grammatical skills?	Not helpful at all - very helpful
Q7. How often do you engage in discussions about technology use in your classroom?	Q7. How often do you engage in discussions about grammar with your peers or teacher?	Never - always
Q8. How motivated are you to use technology for teaching/learning?	Q8. How motivated are you to learn English grammar?	Not motivated at all - very motivated

Table 2: Interview questions

	Interview question
Q1	Experiential narrative of grammar learning: Could you elucidate upon your experiential journey with English grammar learning, highlighting any particular obstacles or triumphs you have encountered along this path?
Q2	Strategic engagement with grammar exercises and assignments: What methodologies or approaches do you employ in tackling grammar exercises and assignments? Please elaborate on any specific strategies or routines that you find instrumental.
Q3	Feedback reception and perception in grammar learning: How do you interpret and respond to feedback regarding your grammatical performance? Discuss the significance of such critiques in the continuum of your learning progression.
Q4	Efficacy of self-regulated learning in grammar acquisition: Could you expound on the manner in which self-regulated learning strategies have augmented your comprehension and mastery of English grammar?
Q5	Case study of self-regulated learning application: Please recount a particular instance wherein you utilized a self-regulated learning strategy to fortify your grammatical capabilities. What were the outcomes of this endeavor?
Q6	Pedagogical enhancements for grammar instruction: In your view, what modalities can English educators adopt to facilitate a more effective grammar learning experience for students? Are there certain pedagogical practices or methodologies that you deem most efficacious?
Q7	Identifying challenges in grammar acquisition: What elements of English grammar acquisition do you perceive as most daunting, and what factors contribute to these challenges? How do these challenges impact your overall learning trajectory?
Q8	Maintaining engagement and motivation in grammar studies: What strategies or resources do you employ to sustain your engagement and motivation whilst studying English grammar? Are there particular tools or practices that you find exceptionally beneficial?

3.4. Research procedures

The development, deployment, and assessment of the MSRL grammar module are meticulously underpinned by a foundational framework that integrates established principles of English language pedagogy, advancements in technology-enhanced learning, and contemporary grammar instruction methodologies. This comprehensive approach is informed by seminal works within the academic field, ensuring a robust and scholarly grounded process.

In the initial phase of needs analysis, the study adopts methodological guidelines derived from Dörnyei and Taguchi's (2009) seminal work on crafting questionnaires for research in second language acquisition. This foundational text provides a rigorous framework for designing questions that effectively capture the nuanced learning needs and preferences of participants, thereby ensuring that the development of the MSRL grammar module is informed by a thorough understanding of the target demographic.

The design and development phase of the MSRL grammar module draws inspiration from the principles of sociocultural theory articulated by Lantolf et al. (2015). Their insights into the social and cultural dimensions of second language acquisition guide the creation of a module that not only enhances grammatical competence but also fosters a supportive learning environment that encourages collaboration, reflection, and growth.

For the crucial stage of evaluating the effectiveness of the MSRL module, the study relies on the mixed methods approach advocated by Creswell and Creswell (2017). Their comprehensive framework for research design offers a balanced methodology that combines qualitative and quantitative research methods. This dual approach facilitates a multifaceted analysis of the module's impact, examining both its usability and its influence on enhancing learners' grammatical skills. Through this rigorous evaluative process, this study aims to provide a detailed understanding of the effectiveness of the MSRL module in improving grammatical proficiency, thereby contributing valuable insights to the field of language education.

3.5. Data collection and analysis procedures

In this study, data collection was strategically tailored to encompass both quantitative and

qualitative dimensions, utilizing questionnaires for the quantitative component and semi structured interviews for the qualitative aspect. This dual-pronged approach ensured a comprehensive exploration of the subject matter, enabling a nuanced understanding of the phenomena under investigation.

Quantitative data were collected through carefully designed questionnaires aimed at capturing a broad spectrum of information regarding participant demographics and their perceptions of technology's role in English-language learning. The data analysis encompassed the utilization of reliability and validity measures, descriptive statistics, and concise summarizations of participant backgrounds and attitudes. This study was facilitated by SPSSPRO (spsspro.com), an online tool specifically designed for social science data analysis. This statistical examination was pivotal in sketching a detailed portrait of the study's demographic context and in highlighting prevailing dispositions towards the adoption of technology in language education. On the qualitative front, semi structured interviews served as the primary vehicle for gathering in-depth insights into the participants' experiences and perspectives. The accuracy and authenticity of these interviews were preserved through verbatim transcription, ensuring that the richness of the participants' voices and experiences was maintained. Following transcription, a content analysis was conducted to extract and interpret the meaningful content embedded within the text data. This analysis employed a systematic approach to coding and thematic categorization, identifying and elucidating recurring themes and patterns in participant responses. The emergence of these themes was instrumental in deepening the understanding of participants' subjective experiences, thereby enhancing the depth and breadth of the study's findings.

4. Questionnaire results

4.1. Participant demographics

The comprehensive demographic summary of the participants in the study was organized into sex, status, and age groups. The participant group consisted of a total of 305 individuals, which were divided into 135 female students, 25 female teachers, 130 male students, and 15 male teachers. This distribution indicates a balanced gender representation among both students and teachers, with a slightly greater number of female participants overall. The participants were predominantly in the age ranges of 12--14 years and 15--17 years, with 115 and 116 individuals, respectively, reflecting the primary demographic characteristics of secondary school students. The 18–20 year age group includes 34 individuals, suggesting the presence of older students or young teachers. Additionally, there were 21 individuals in the 21–40 years age group and 19 in the 41–60 years age group, likely representing the teacher participants. No participants were reported to be in the age groups younger than 12 years or older than 60 years, which aligns with the expected age range for secondary school students and teachers.

This demographic breakdown provides a detailed view of the study's participant composition, highlighting the diversity in gender and age while maintaining a focus on the target populations of secondary school students and teachers.

4.2. Reliability and validity

In the context of this study, which aimed to explore the impact of technology on English-language learning among secondary school students and teachers, the reliability and validity of the scale questions in the questionnaire were rigorously evaluated to ensure the robustness of the findings.

Table 3 shows how the deletion of each item impacts the overall Cronbach's alpha and the correlation of the item with the total scale. Items Q5 and Q1 have the highest correlations with the total score (0.408 and 0.389, respectively), indicating that these items contribute significantly to the scale's reliability. Deleting Q2 results in a slight improvement in Cronbach's alpha (0.644), suggesting that this item may be less consistent with the other items. Overall, Cronbach's alpha values after deleting individual items range from 0.621 to 0.647, indicating moderate internal consistency across the scale.

Table 3: Deletion of statistical summaries of analyzed items

Items	Average value after deletion of items	Variance after deletion of items	Correlation of deleted items with the total after deletion of items	Cronbach's alpha coefficient after deletion of items
Q1	28.452	2.288	0.389	0.626
Q2	28.469	2.237	0.32	0.644
Q3	28.443	2.254	0.344	0.637
Q4	28.436	2.207	0.389	0.625
Q5	28.446	2.254	0.408	0.621
Q6	28.423	2.278	0.368	0.631
Q7	28.393	2.279	0.33	0.64
Q8	28.426	2.324	0.303	0.647

Furthermore, the questionnaire's construct validity, as shown in Table 4, was assessed through the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity. The KMO measure of sampling adequacy was found to be 0.795, which is well above the commonly accepted threshold of 0.6, suggesting that the sample size was adequate for the analysis and that the factor analysis of the questionnaire

items is likely to be reliable. Bartlett's test of sphericity yielded an approximate chi-square value of 226.684 with 28 degrees of freedom and a significance level of p<0.0001, indicating that the variables are sufficiently correlated for factor analysis and thus confirming the construct validity of the scale.

Table 4: KMO and Bartlett's test results

KMO value		0.795
Bartlett's test of sphericity	Approximate chi-square	226.684
	df	28
	P	0.000***

***: represents 1% level of significance

4.3. Descriptive analysis

This descriptive analysis provides insightful data on the responses to the questionnaire items (Q1--Q8) utilized in the study, which explore the integration of technology in English-language learning among secondary school students and teachers. The analysis includes a range of statistical measures that shed light on the distribution and variability of responses across the sample of 305 participants. Table 5 presents the analysis results for each questionnaire item, including the sample size, maximum value, minimum value, mean, standard deviation, median, variance, kurtosis, skewness, and coefficient of variation (CV).

The responses across all the items ranged from a minimum value of 3 to a maximum of 5, indicating that no participants selected the lowest possible rating (1 or 2) for any of the questions. This trend suggests a generally positive attitude or experience among the participants concerning the aspects of technology use in English-language learning being measured.

The mean scores for the items fluctuated slightly at approximately 4.0, with the lowest average being 4.030 (Q2) and the highest being 4.105 (Q7). These averages indicate that, on the whole, participants tended to rate their agreement or satisfaction towards the higher end of the scale, reflecting favorable perceptions or experiences.

The standard deviations were relatively low across all the items, ranging from 0.351-0.424, which points to a narrow spread of responses around the mean. This homogeneity suggests that there was a general consensus among participants on the issues addressed by the questionnaire items.

Kurtosis and skewness values provide insight into the peakness and asymmetry of the distribution of responses, respectively. The positive kurtosis values indicate a leptokurtic distribution, meaning that responses are more peaked and concentrated around the mean than a normal distribution. Positive skewness values suggest a slight tendency for the distribution of responses to tail off to the right, although these values are relatively low, indicating that this tendency is not pronounced.

The CV, a measure of relative variability, was consistently low across all the questions (ranging from 0.087 to 0.105), suggesting that the degree of variation in the responses relative to the mean was minimal. This further supports the notion of a strong consensus among the study participants.

In the context of this study, the descriptive analysis underscores a broadly positive reception and uniform agreement among participants regarding the integration of technology in English-language learning. The lack of low scores (1 or 2) across all items, combined with the relatively high mean scores and low variability, suggests a cohesive and favorable view of the subject matter being investigated.

Table 5: Descriptive analysis summary

Question	Maximum value	Minimum value	Mean	Standard deviation	Median	Variance	Kurtosis	Skewness	CV
Q1	5	3	4.046	0.351	4	0.123	4.947	0.678	0.087
Q2	5	3	4.03	0.424	4	0.18	2.582	0.18	0.105
Q3	5	3	4.056	0.398	4	0.158	3.162	0.47	0.098
Q4	5	3	4.062	0.397	4	0.157	3.126	0.53	0.098
Q5	5	3	4.052	0.359	4	0.129	4.511	0.701	0.089
Q6	5	3	4.075	0.368	4	0.136	3.798	0.896	0.09
Q7	5	3	4.105	0.392	4	0.153	2.637	0.935	0.095
Q8	5	3	4.072	0.382	4	0.146	3.425	0.728	0.094

5. Interview findings

This study engaged a diverse group of interviewees to explore the intricacies of English grammar learning and teaching experiences. As Table 6 shows, the participants included 10 students and 3 teachers, each bringing unique perspectives to the investigation. The students designated S1 through S10, ranged in age from 12-17 years, reflecting the typical age range of middle school students. This age distribution ensures that the study captures a wide array of learner experiences and challenges at different stages of adolescence. On the other hand, the teachers identified as T1 through T3 offered professional insights from a broader age

spectrum, ranging from 29-47 years. This diversity in age among the teachers allowed for a rich examination of pedagogical practices and experiences across different stages of a teaching career.

In the comprehensive analysis of interviews conducted with 10 students (S1--S10) and 3 teachers (T1--T3), the discourse illuminated a rich tapestry of experiences and pedagogical strategies within the realm of English grammar education.

The participants narrated diverse experiential narratives regarding their journeys through English grammar learning, characterized by a blend of obstacles and achievements. The complexity of grammar rules emerged as a notable challenge

among students, with S3 reflecting, "I often struggle to apply these rules in my writing, which can be frustrating" (S3). Conversely, teachers documented observable progress following targeted exercises, with T1 remarking, "Interactive exercises have been transformative for many students, marking a clear before and after in their understanding" (T1).

Table 6: Interviewer information

Interviewee number	Role	Age
S1	Student	13
S2	Student	14
S3	Student	12
S4	Student	14
S5	Student	13
S6	Student	15
S7	Student	16
S8	Student	17
S9	Student	15
S10	Student	16
T1	Teacher	35
T2	Teacher	29
T3	Teacher	47

The theme of strategic engagement with grammar exercises was prevalent, emphasizing the adoption of a variety of methodologies. "Practice quizzes and peer reviews have truly changed the game for me," S6 highlighted, pointing to the effectiveness of diverse strategies (S6). T2 emphasized the pivotal role of technology, stating, "Language learning apps have complemented traditional methods effectively, offering students a more engaging way to practice" (T2).

Feedback was considered crucial by both students and teachers. S4 articulated the value of personalized feedback: "It is not just about knowing I made a mistake, but understanding how to fix it" (S4). T3 shared a similar sentiment, emphasizing the moment of comprehension: "Seeing the lightbulb moment when a student understands the feedback is incredibly rewarding" (T3).

Self-regulated learning strategies were identified as essential for mastering English grammar. S7 shared their success story: "Setting personal goals and regularly assessing myself has boosted my grammar skills significantly" (S7). T1 supported this view, observing deeper comprehension among proactive students: "Students who take charge of their learning process tend to grasp grammar concepts more deeply" (T1).

An effective case study highlighted the impact of daily grammar journals, with S5 noting, "Keeping a daily journal made me more conscious of the grammar I use and helped solidify my learning" (S5). This practice was praised by teachers for fostering self-directed learning and improving writing clarity.

With respect to pedagogical enhancements, T3 advocated for interactive teaching methods: "Incorporating more group discussions and real-life writing tasks can make learning grammar feel more relevant" (T3). This perspective was echoed by both students and teachers, who valued the integration of multimedia resources into the curriculum for a richer learning experience. Challenges in grammar acquisition, particularly the breadth of rules and

exceptions, were frequently mentioned. "Just when you think you have got a rule down, there's an exception," lamented S8, underscoring the complexity and frustration associated with grammar learning (S8).

Finally, the importance of maintaining engagement and motivation was acknowledged. T2 mentioned innovative strategies, "game-based learning and competitive activities," as effective in keeping students interested (T2). S10 shared their positive experience: "These methods make learning grammar not only educational but also fun" (S10).

The interviews with both students and teachers shed light on the multifaceted challenges of learning English grammar, revealing a notable discrepancy between theoretical understanding and practical application. Like S3, students expressed frustration over the difficulty in applying complex grammar rules to their writing, a sentiment echoed across the student responses, indicating a widespread struggle with the abstract nature of grammar rules. Conversely, teachers, as illustrated by T1, observed significant improvements when employing interactive exercises, suggesting that the disconnect students experience might be mitigated through more engaging and application-focused teaching methods. This juxtaposition of student challenges and teacher observations underscores the need for a pedagogical approach that bridges the gap between the theoretical aspects of grammar and its practical use, highlighting interactive exercises as a potential key to enhancing student understanding and engagement with English grammar.

Furthermore, the importance of feedback and self-regulated learning strategies emerged as common threats linking student experiences with teacher practices. Students such as S4 emphasized the transformative impact of personalized feedback on their learning progress, a view supported by teachers such as T3, who noted the motivational boost provided by understanding and acting upon constructive feedback. The advocacy for self-regulated learning strategies by both students and teachers, with S7's testament to set personal goals and T1's observation of its effectiveness, reveals a shared belief in the power of self-directed learning to deepen grammatical comprehension. These insights underline a collective vision for grammar education that values engagement, practicality, and individualized learning pathways, pointing toward a more integrated and responsive approach to teaching English grammar that aligns with the diverse needs and experiences of students.

6. Discussion

The findings underscore the significant role of SRL and multimodal strategies in improving students' grammatical competencies, aligning with the assertions of Azevedo et al. (2022) regarding the potential of personalized learning strategies to boost educational outcomes. The positive reception of the MSRLG module among students and teachers

corroborates the literature advocating for more engaging and interactive approaches to grammar instruction (Phengsuai and Suwanarak, 2020). This affirmation of the literature underscores the necessity of evolving traditional grammar teaching methodologies to incorporate elements that resonate with learners' preferences and learning styles.

Beyond the specific context of Beijing, the implications of this study extend to broader educational settings. The MSRLG module's emphasis on self-regulation and multimodal learning strategies offers promising applications for grammar instruction in diverse educational systems, especially those grappling with the limitations of traditional teacher-centered approaches. For example, educational environments in which students are required to become more autonomous in their learning, such as in blended or remote learning models, could greatly benefit from the integration of self-regulated learning frameworks such as the MSRLG module. The development of such competencies prepares students not only to master grammatical concepts but also to take ownership of their learning processes, a skill that is increasingly relevant in modern, technologically driven classrooms.

However, our study extends beyond the existing discourse by providing empirical evidence on the specific effectiveness of the MSRLG module within a junior high school context in Beijing, thereby filling a gap in the literature regarding the application of SRL and multimodal strategies in enhancing the grammatical understanding of this demographic. Unlike Hornberger and Link (2012), who critiqued the predominantly teacher-led model for its superficial engagement with grammatical concepts, our research illustrates how a blend of classroom instruction with external self-regulation can foster a deeper, more practical understanding of grammar.

In addition, the implications of this study are not confined to grammar instruction alone. The principles of SRL and multimodal teaching could be extended to other areas of language education, such as reading comprehension, writing, and oral communication, where students' active engagement and self-regulatory skills are crucial. In particular, educational systems that are shifting toward competency-based curricula could adopt the MSRLG framework to better align with the goals of developing autonomous learners who can effectively apply their knowledge in real-world contexts.

While our findings largely support the literature on the benefits of SRL and multimodal learning approaches, our study reveals a nuanced picture of the challenges students face in mastering grammar. In contrast to Batstone and Ellis (2009), who highlighted the disconnect between theoretical understanding and practical application as a primary challenge, our qualitative insights suggest that this gap can be effectively bridged through targeted interventions such as the MSRLG module. This difference may be attributed to the specificities of our intervention, which uniquely combines SRL strategies with multimodal teaching, thus offering a more holistic approach to grammar education than previously discussed in the literature.

One of the broader implications of these findings is the potential for adapting the MSRLG module to different linguistic and cultural contexts. While the current study focused on English language learners in Beijing, the principles of self-regulated learning and multimodal teaching are flexible and could be tailored to other language learning environments, whether in Western educational systems or in non-English-speaking countries. This adaptability makes the MSRLG module an attractive model for international education programs that seek to integrate technology- and student-centered pedagogies into their curricula.

Moreover, the study's focus on the perspectives of both students and teachers provides a comprehensive view of the educational ecosystem surrounding grammar instruction. While previous studies have often concentrated on student experiences or pedagogical strategies in isolation, our research highlights the interplay between teacher readiness, student engagement, and the efficacy of instructional methods. This dual focus reveals the critical role of teacher support and professional development in implementing innovative teaching strategies, a dimension that has been less emphasized in prior research.

Teacher professional development is another crucial consideration in the broader application of the MSRLG module. As teachers become more familiar with integrating technology into their grammar instruction, they will need support in transitioning from traditional instructional methods to multimodal and self-regulated learning frameworks. Educational policymakers and school administrators should consider developing targeted training programs that equip teachers with the skills and confidence to implement these innovative teaching strategies. This need for professional development is particularly pressing in under-resourced educational settings, where both technological infrastructure and teacher expertise may be limited.

The congruence between our study's outcomes and the positive perspectives on SRL and multimodal learning in the literature suggest a growing consensus on the need for educational practices that are both engaging and personalized. However, our research also emphasizes the importance of context-specific studies to explore how these general principles can be best applied in different educational settings and cultures.

Furthermore, the scalability of the MSRLG module is an important consideration for future research. While the module has demonstrated effectiveness in a specific context, studies should investigate how it can be scaled to larger educational systems or integrated into national curricula. Potential challenges, such as varying levels of technological access and differences in educational policies, should be explored to ensure the broad

applicability of the module across diverse educational landscapes.

Future research should aim to expand upon our findings by exploring the long-term impacts of the MSRLG module and similar interventions across diverse educational contexts. Additionally, studies could investigate the scalability of such modules and the potential barriers to their widespread adoption, including teacher training requirements and the integration of technology in under-resourced schools.

Overall, this study not only reinforces the value of integrating SRL and multimodal approaches into grammar education but also contributes novel insights into their application within a specific educational setting. By bridging theoretical insights with empirical evidence, this research offers valuable contributions to the ongoing dialogue on enhancing grammatical competence through innovative educational strategies. The potential for broader application in other educational settings, the need for teacher professional development, and the scalability of the MSRLG module offer exciting directions for future research and policy development.

7. Conclusion

In this mixed-methods study, a comprehensive investigation into the challenges and strategies associated with learning and teaching English grammar was undertaken, incorporating both quantitative and qualitative dimensions. The quantitative analysis, encompassing a wide participant base of 305 individuals through questionnaires, revealed a generally positive disposition toward the integration of technology in English-language learning, underpinned by moderate levels of engagement and satisfaction. This finding is indicative of a burgeoning recognition of the role that technology can play in enhancing the grammar learning experience. The qualitative component, involving in-depth interviews with 10 students and 3 teachers, provided a richer, more nuanced understanding of the experiences, challenges, and pedagogical strategies in grammar education.

The interviews shed light on the intricate terrain of English grammar acquisition, characterized by students' difficulties in applying grammar rules and teachers' observations of progress through interactive tasks. This dichotomy underscores the need for pedagogical approaches that bridge theoretical knowledge and practical application, with interactive exercises emerging as a key strategy for enhancing understanding and engagement. Furthermore, both students and teachers emphasized the significance of feedback and self-regulated learning strategies, highlighting the transformative impact of personalized feedback on learning progression and the efficacy of self-directed learning in fostering a deeper comprehension of grammar.

The synthesis of the quantitative and qualitative findings of this study underscores a shared enthusiasm among students and teachers for innovative strategies that make grammar learning more engaging, relevant, and tailored to individual needs. The positive perceptions towards the use of technology, as revealed through the questionnaires, complement the qualitative insights into the benefits of interactive exercises, personalized feedback, and self-regulated learning strategies. This convergence suggests that a multifaceted approach incorporating technology, interactive pedagogy, and individualized feedback holds significant promise for addressing the challenges of grammar education.

The findings of this study are applicable beyond the context of English grammar education in Beijing and can be adapted to other educational settings. Self-regulated learning and multimodal strategies are relevant in diverse contexts, including other subjects and educational systems. These strategies could also be beneficial in multilingual or resource-constrained environments where student engagement and autonomy are key challenges.

In conclusion, this study contributes valuable insights into the evolving dynamics of English grammar learning and teaching, highlighting the critical role of engagement, practicality, and individualized approaches in enhancing the grammar learning experience. The findings advocate for a collaborative effort between educators and learners to integrate technology and interactive methodologies into grammar instruction, thereby fostering a more inclusive, responsive, and effective educational environment. Future research should continue to explore innovative pedagogical strategies and technology applications, with a focus on their impact on student motivation, engagement, and achievement in grammar learning.

Compliance with ethical standards

Ethical considerations

Informed consent was obtained from all participants and, for minors, from their legal guardians. All data were anonymized and securely stored to protect participants' privacy.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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