KMANPUB | AI and Tech in Behavioral and Social Sciences Vol. 4 No. 3 (2026): 1-9

Article history:
Received 01 March 2026
Revised 02 June 2026
Accepted 09 June 2026
Initial Publication 19 June 2026
Final Publication 01 July 2026

Integrating the SQ6R Strategy into a Personalized Adaptive System for Selected Reading Subskills in Blended EFL Learning

Nima Alizadeh[1], Mehran Davaribina[2*], Reza Khorasani[2]

1. PhD Candidate, Department of English Language, Ard.C., Islamic Azad University, Ardebil, Iran
2. Assistant Professor, Department of English Language, Ard.C., Islamic Azad University, Ardebil, Iran

*** Corresponding author email address:** m.davaribina@iauardabil.ac.ir

A r t i c l e I n f o

Article type:
Original Research

How to cite this article:
Alizadeh, N., Davaribina, M., & Khorasani, R. (2026). Integrating the SQ6R Strategy into a Personalized Adaptive System for Selected Reading Subskills in Blended EFL Learning. *AI and Tech in Behavioral and Social Sciences, 4*(3), 1-9.
https://doi.org/10.61838/kman.aitech.5608

A B S T R A C T

This study examined the effectiveness of ELINA, a rule-based personalized adaptive learning system that integrates the SQ6R reading strategy, for improving selected reading subskills among Iranian intermediate EFL learners in a blended learning environment. A concurrent mixed-methods quasi-experimental design was used. After screening with the Cambridge Preliminary English Test, 258 B1-level learners were assigned to an experimental group (n = 135) receiving ELINA-supported blended instruction and a control group (n = 123) receiving traditional teacher-fronted instruction. Quantitative outcomes focused on post-intervention scores for vocabulary-in-context, inferential comprehension, and overall comprehension, while qualitative evidence was collected through learner perception data and semi-structured interviews. Post-intervention comparisons showed large advantages for the experimental group in vocabulary-in-context (mean difference = 8.30, t = 11.71, p < .001, d = 1.47) and inferential comprehension (mean difference = 7.30, t = 10.87, p < .001, d = 1.37). The group difference in overall reading comprehension was small and not statistically significant (mean difference = 1.40, p = .110, d = 0.20). Qualitative findings indicated that ELINA supported motivation, perceived autonomy, feedback uptake, and reduced reading-related anxiety, while learners still valued teacher mediation for higher-order interpretation. The findings suggest that adaptive systems are most useful when they operate as pedagogically transparent scaffolds within blended instruction rather than as replacements for teachers. ELINA appears particularly effective for strengthening subskills that depend on repeated exposure, immediate feedback, and individualized remediation, whereas broader comprehension gains may require longer interventions and more explicit discourse-level instruction. Accordingly, the conclusions are limited to targeted subskill improvement rather than confirmed improvement in overall reading comprehension.

Keywords: *adaptive learning; SQ6R; EFL reading; blended learning; reading subskills*

1. Introduction

Reading comprehension is a central component of English as a Foreign Language (EFL) learning because it links lexical knowledge, syntactic processing, background knowledge, inference making, and metacognitive monitoring (Brown, 2014; Grabe & Stoller, 2019). In many EFL classrooms, however, reading instruction remains largely uniform and teacher-fronted. Such instruction can be efficient for content coverage, but it often fails to accommodate differences in learner pace, vocabulary knowledge, strategy use, and affective readiness. These differences are particularly important at the intermediate level, where learners may decode the surface meaning of a text but struggle with inference, cohesion, and discourse-level integration.

Technology-enhanced learning has created new opportunities for addressing this instructional mismatch in EFL instruction (Al-Jarf, 2021; Khodabakhshzadeh et al.,

2024). Adaptive learning systems can collect performance and behavioral data, identify patterns in learner response, and provide differentiated feedback or remediation (Siemens & Baker, 2012; Zawacki-Richter et al., 2019). In language education, this affordance is valuable because comprehension is not a single ability but a composite of interacting subskills. A learner may need vocabulary support, another may need inference practice, and a third may need guidance in recognizing discourse organization. A well-designed adaptive system can support these differences more consistently than a single classroom sequence.

The pedagogical challenge is that adaptive systems are not automatically effective simply because they are technological. Their value depends on whether their logic is aligned with a defensible learning strategy and whether the teacher remains involved in interpretation, motivation, and higher-order guidance (Roll & Wylie, 2016; VanLehn, 2011). Feedback quality is also central because learning benefits depend on whether feedback is timely, specific, and usable (Hattie & Timperley, 2007; Wisniewski et al., 2020). For this reason, the present study focuses on ELINA, a rule-based personalized adaptive learning system that embeds the SQ6R strategy into blended EFL reading instruction. SQ6R organizes reading into Survey, Question, Read, Recite, Record, Review, and Reflect stages, extending earlier structured reading traditions such as SQ3R (Robinson, 1941; Thakhulee et al., 2025). In ELINA, these stages are converted into structured digital tasks, mastery checks, feedback prompts, and remediation pathways.

This study is positioned at the intersection of learning analytics, adaptive educational technology, and behavioral engagement in EFL reading (Kizilcec et al., 2013; Siemens & Baker, 2012). It addresses a practical and theoretical gap: reading strategies are frequently taught as fixed classroom routines, whereas adaptive technologies are often evaluated as tools without sufficient attention to the underlying cognitive strategy. Integrating SQ6R with a transparent adaptive system may therefore offer a more pedagogically grounded model for technology-supported reading instruction.

The study addressed the following research questions:

Does ELINA-supported blended instruction produce stronger post-intervention outcomes in selected reading subskills and overall comprehension than traditional teacher-fronted instruction among B1-level Iranian EFL learners?

Which reading subskills show the clearest response to the ELINA intervention?

How do learners perceive ELINA in terms of motivation, engagement, autonomy, feedback, and usability?

How do the quantitative and qualitative findings jointly explain the role of adaptive SQ6R-based instruction in EFL reading?

2. Literature Review and Theoretical Framework

2.1. Adaptive Learning and Learning Analytics in Language Education

Adaptive learning systems are designed to adjust learning content, feedback, or task sequencing in response to learner performance (Siemens & Baker, 2012). In the broader field of artificial intelligence in education, such systems range from rule-based platforms to more complex intelligent tutoring systems. Their common premise is that learning improves when instruction is calibrated to the learner's current state rather than delivered as a fixed sequence to all learners. Research on intelligent tutoring and AI-supported education has emphasized the importance of feedback, learner modeling, and instructional adaptivity, while also warning that technological sophistication alone does not guarantee pedagogical effectiveness (Roll & Wylie, 2016; VanLehn, 2011; Zawacki-Richter et al., 2019).

Learning analytics further contributes to this field by making learner behavior visible (Kizilcec et al., 2013; Siemens & Baker, 2012). Accuracy, response time, repeated attempts, inactivity, and help-seeking behavior can be used to infer the type of support a learner may need. In EFL reading, such analytics are especially useful because comprehension difficulties often appear differently across learners: some are vocabulary-based, others are inferential, and others reflect problems with cohesion or text structure (Al-Jarf, 2021; Grabe & Stoller, 2019). The present study therefore treats ELINA not as a replacement for instruction but as a data-informed scaffold embedded in a teacher-mediated blended environment.

2.2. SQ6R as a Structured Reading Strategy

SQ6R extends earlier active-reading traditions such as SQ3R by requiring learners to approach reading as an intentional, staged process rather than as passive exposure to text (Robinson, 1941; Thakhulee et al., 2025). The

AITBSS
AI and Tech in Behavioral and Social Sciences
E-ISSN: 3041-9433

strategy begins with surveying the text to activate expectations, generating questions to establish purpose, reading for meaning, reciting key information, recording important content, reviewing understanding, and reflecting on comprehension. These stages are compatible with metacognitive models of reading because they encourage learners to plan, monitor, and evaluate their own comprehension (Zimmerman, 2002).

Despite its instructional value, SQ6R can become mechanical if it is applied uniformly. A learner who already understands vocabulary may need inference prompts rather than additional glosses; another who struggles with lexical meaning may need repeated exposure and contextualized vocabulary support before inferential work becomes feasible. This is where adaptive implementation becomes pedagogically meaningful. ELINA operationalizes SQ6R as a sequence of data-informed reading actions in which the next task is selected according to learner performance and engagement (Roll & Wylie, 2016; Siemens & Baker, 2012).

2.3. *Feedback, Self-Regulation, and Behavioral Engagement*

Feedback is one of the strongest but most variable influences on learning. Its effect depends on timing, specificity, clarity, and whether learners can use it to close the gap between current performance and the intended outcome (Hattie & Timperley, 2007; Wisniewski et al., 2020). Adaptive systems can offer immediate and repeated feedback, but teacher mediation remains essential for helping learners interpret feedback at a deeper level (VanLehn, 2011). This is especially relevant in reading comprehension, where correct-answer feedback may improve vocabulary recognition but may not be sufficient for discourse-level reasoning.

Self-regulated learning is also central to adaptive reading because learners must notice comprehension gaps, select strategies, persist through difficulty, and evaluate whether their understanding has improved (Zimmerman, 2002). By making progress visible and routing learners through targeted activities, ELINA is intended to strengthen not only performance but also perceived autonomy and engagement. This behavioral dimension is important because platform data can reveal different engagement patterns that are not always visible in whole-class instruction (Kizilcec et al., 2013).

2.4. *Theoretical Assumptions*

The study draws on two complementary theoretical perspectives. First, Vygotsky's Zone of Proximal Development supports the idea that learners benefit from assistance calibrated to their current level of development (Vygotsky, 1978). In ELINA, calibration occurs through mastery thresholds, feedback, and remediation routes. Second, Cognitive Load Theory suggests that learners have limited working-memory resources and may benefit when extraneous load is reduced (Sweller, 1988). By providing glossaries, guided prompts, and targeted practice, ELINA may reduce unnecessary processing demands and allow learners to allocate more attention to meaning construction; multimedia and contextual support have also been shown to support vocabulary learning in second-language reading contexts (Chun & Plass, 1996).

On this basis, the study expected stronger gains in subskills directly supported by adaptive feedback, particularly vocabulary-in-context and inference. Broader overall comprehension was expected to improve more gradually because it depends on the integration of multiple subskills, sustained strategy use, and discourse-level interpretation over time (Grabe & Stoller, 2019).

3. Methods and Materials

3.1. *Research Design*

The study used a concurrent mixed-methods quasi-experimental design with a nonequivalent pretest-posttest control group structure. This design was appropriate because the quantitative strand examined between-group post-intervention differences in reading outcomes, while the qualitative strand explored learners' perceptions of motivation, engagement, autonomy, usability, and feedback (Creswell & Plano Clark, 2018). Because instruction was implemented in real classroom conditions, full individual randomization was not feasible; therefore, the design prioritized ecological validity while using baseline screening and group-allocation procedures to reduce selection bias. Accordingly, the inferential results are interpreted as post-intervention group comparisons.

3.2. *Participants and Setting*

The initial participant pool consisted of 281 Iranian EFL learners. After screening with the Cambridge Preliminary English Test (PET), 258 learners at the B1 level were retained for the final sample. The experimental group

AITBSS
AI and Tech in Behavioral and Social Sciences
E-ISSN: 3041-9433

included 135 learners and the control group included 123 learners. The experimental group received ELINA-supported blended instruction, whereas the control group received traditional teacher-fronted reading instruction. PET screening was used to restrict the sample to the B1 level.

Table 1

Participant allocation and data sources

Component	Description
Initial pool	281 Iranian EFL learners
Final sample	258 B1-level learners screened by the Cambridge Preliminary English Test
Experimental group	135 learners; ELINA-supported blended SQ6R instruction
Control group	123 learners; traditional teacher-fronted reading instruction
Quantitative evidence	Post-intervention scores for vocabulary-in-context, inferential comprehension, and overall comprehension
Qualitative evidence	Learner perception questionnaire and semi-structured interviews with 15 experimental participants
System evidence	ELINA interaction logs used descriptively to verify platform engagement and adaptive routing

3.3. Instruments

Four instruments were used. First, the Cambridge Preliminary English Test was used for screening and placement. Second, a reading comprehension test measured overall comprehension and selected subskills, including scanning, main idea identification, inference, vocabulary-in-context, cohesion, and discourse organization. The reported quantitative outcomes were vocabulary-in-context, inferential comprehension, and overall comprehension. Third, a learner perception questionnaire assessed usability, motivation, engagement, personalization, and feedback. Fourth, semi-structured interviews were conducted with 15 experimental-group learners to obtain deeper qualitative evidence about their experience with ELINA. ELINA log files were also used descriptively as system-level evidence of engagement and adaptive pathway completion.

3.4. ELINA System and SQ6R Integration

ELINA is a rule-based adaptive learning system designed by the researcher to provide transparent instructional adaptation. Rather than using an opaque algorithmic model, ELINA applies explicit pedagogical decision rules based on learner accuracy, response time, repetition history, and engagement patterns (Siemens & Baker, 2012). If learners do not meet a mastery threshold, the system redirects them to supportive materials such as vocabulary glossaries, instructional videos, guided note-taking activities, and remedial comprehension tasks. Such contextual and multimedia support is particularly relevant to vocabulary learning in second-language reading (Chun & Plass, 1996). The aim is to keep learners within an achievable level of challenge while maintaining teacher oversight.

Table 2

Pedagogical mapping of SQ6R stages to ELINA adaptive functions

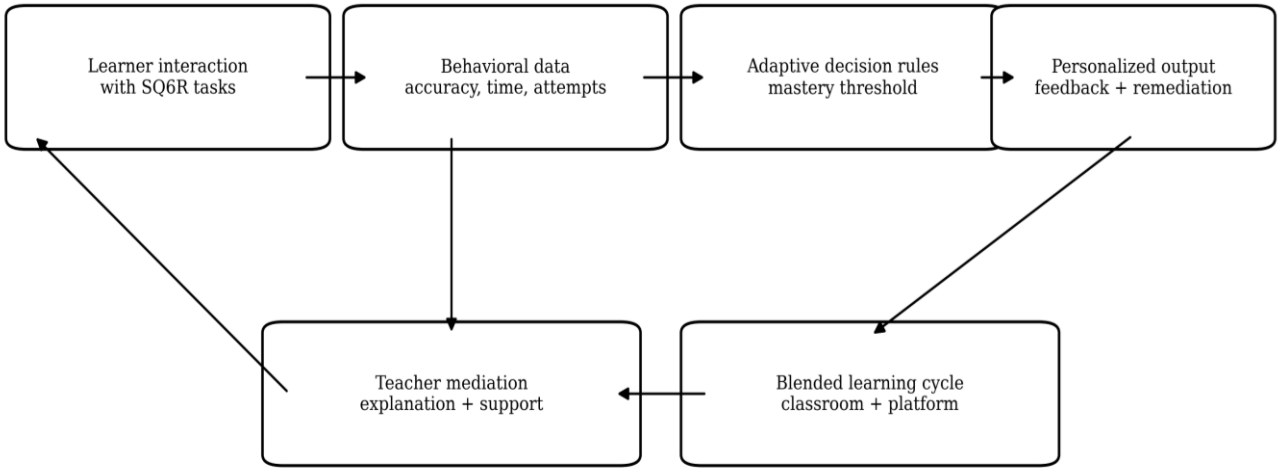
SQ6R stage	Learner action	Behavioral or performance indicator	ELINA adaptive response
Survey	Preview title, headings, visuals, and text structure	Completion of preview prompts; time spent on preview	Activates short orientation prompts and text-structure cues
Question	Generate guiding questions before reading	Number and relevance of learner-generated questions	Provides sample questions or additional prompts when learner output is limited
Read	Read the passage and respond to comprehension checks	Accuracy, response time, and skipped items	Adjusts task difficulty and directs learner to glosses or guided rereading
Recite	Restate key ideas in learner's own words	Completeness of recall and task completion	Provides feedback prompts and model summaries
Record	Take structured notes on vocabulary and main ideas	Note completion and repetition history	Adds vocabulary support or guided note templates
Review	Revisit missed items and earlier questions	Patterns of incorrect responses and repeated attempts	Routes learner to remedial tasks and targeted practice
Reflect	Evaluate comprehension and strategy use	Self-report of difficulty and confidence	Suggests next-step strategy reminders and teacher follow-up points

Figure 1

Conceptual architecture of ELINA as a rule-based adaptive scaffold for SQ6R reading in blended EFL instruction.

AITBSS
AI and Tech in Behavioral and Social Sciences
E-ISSN: 3041-9433

ELINA as a rule-based adaptive scaffold for SQ6R reading



3.5. *Procedure*

The study began with PET screening and group allocation. Participants then completed the reading pretest. During the intervention period, the experimental group used ELINA as part of blended reading instruction, combining platform-based adaptive tasks with teacher-mediated classroom activities. The control group followed traditional teacher-fronted reading instruction using the same general reading objectives but without adaptive routing or platform-based individualized feedback. At the end of the intervention, all participants completed the reading posttest and the learner perception questionnaire. A purposive subsample of 15 experimental-group participants participated in semi-structured interviews.

3.6. *Data Analysis*

Quantitative analyses were conducted using post-intervention data. Between-group comparisons were calculated using Welch's independent-samples t-test to avoid relying on the assumption of equal variances. Mean differences, 95% confidence intervals, p-values, and Cohen's d were reported to improve interpretability, following conventional effect-size reporting in behavioral research (Cohen, 1988). ELINA logs were used descriptively to verify engagement and routing. Qualitative interview data were organized thematically with attention to motivation, engagement, autonomy, feedback, and usability. Quantitative and qualitative findings were then integrated through a joint-display approach (Creswell & Plano Clark, 2018).

3.7. *Ethical Considerations*

The study was conducted in accordance with ethical principles for educational research involving human participants. Participation was voluntary, learners were informed about the study purpose and procedures, and data were anonymized before analysis. Digital platform logs were treated as confidential learner records.

4. Findings and Results

4.1. *Quantitative Findings*

The post-intervention comparisons are presented in Table 3. The experimental group outperformed the control group in vocabulary-in-context and inferential comprehension. Both effects were large in magnitude. In contrast, the between-group difference in overall reading comprehension was small and did not reach statistical significance.

Table 3

Post-intervention between-group comparisons

Outcome	Experimental	Control	MD [95% CI]	t (df)	p	d

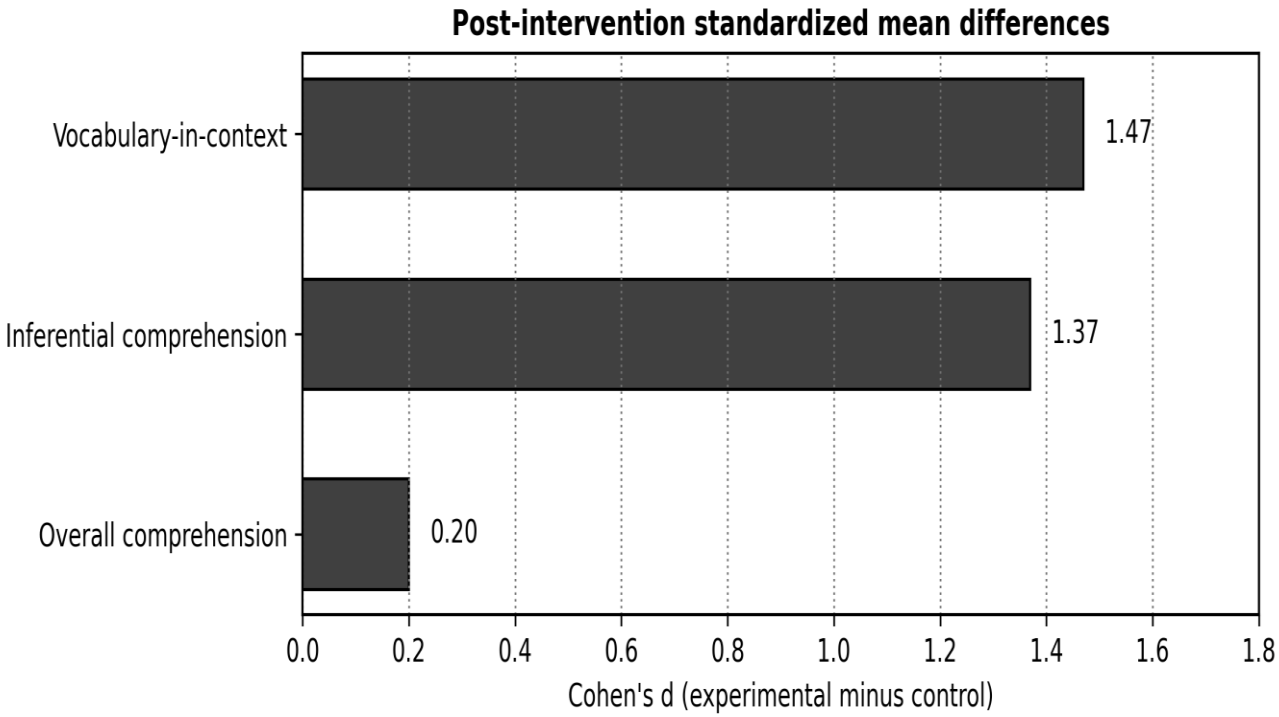
AITBSS
AI and Tech in Behavioral and Social Sciences
E-ISSN: 3041-9433

	M (SD)	M (SD)				
Vocabulary-in-context	82.4 (5.2)	74.1 (6.1)	8.30 [6.90, 9.70]	11.71 (240.9)	< .001	1.47
Inferential comprehension	79.8 (4.9)	72.5 (5.8)	7.30 [5.98, 8.62]	10.87 (239.9)	< .001	1.37
Overall comprehension	76.2 (7.1)	74.8 (6.9)	1.40 [-0.32, 3.12]	1.61 (254.9)	0.110	0.20

Note. Positive values favor the experimental group. Welch's t-test was used. Cohen's d was calculated from pooled standard deviations. Effects were large for vocabulary-in-context and inferential comprehension and small for overall comprehension.

Figure 2

Standardized post-intervention effects of ELINA-supported instruction relative to traditional instruction.



The strongest effect was observed for vocabulary-in-context (d = 1.47), followed by inferential comprehension (d = 1.37). These results indicate that ELINA was most effective for subskills directly supported by immediate feedback, repeated exposure, glossing, and targeted remediation, which is consistent with research on feedback and vocabulary support in learning (Chun & Plass, 1996; Hattie & Timperley, 2007; Wisniewski et al., 2020). The effect for overall comprehension was small (d = 0.20), suggesting that broader reading comprehension may require longer exposure, additional discourse-level instruction, or delayed posttesting to capture transfer from subskill gains to integrated comprehension.

4.2. Qualitative Findings

The qualitative data clarified how learners experienced ELINA. The dominant themes were improved motivation, reduced anxiety, greater perceived control over reading pace, usefulness of immediate feedback, and continued reliance on teacher support for higher-order interpretation. These themes are summarized in Table 4.

Table 4

Qualitative themes from learner perceptions and interviews

Theme	Observed pattern	Interpretive meaning for adaptive reading instruction
Motivation and persistence	Learners reported that task sequencing, progress visibility, and feedback made reading practice more engaging.	Adaptive feedback may increase persistence by making progress more visible and reducing the sense of repeated failure.

AITBSS
AI and Tech in Behavioral and Social Sciences
E-ISSN: 3041-9433

Reduced reading anxiety	Learners described the platform environment as less threatening than immediate public correction in class.	Private practice and individualized remediation can lower affective barriers in EFL reading.
Perceived autonomy	Learners valued the ability to move through tasks at an individualized pace and revisit support materials.	Self-paced adaptive pathways can support self-regulated reading behavior.
Feedback uptake	Immediate feedback helped learners identify vocabulary and inference errors without waiting for teacher correction.	Timely feedback appears especially useful for subskills with clear performance indicators.
Need for teacher mediation	Learners still relied on the teacher for explanation, interpretation, and discussion of complex ideas.	Adaptive systems should complement rather than replace human instruction, especially for higher-order comprehension.
Usability constraints	Some learners noted dependence on device access, internet quality, and familiarity with platform routines.	Technical readiness and orientation remain necessary for effective implementation.

4.3. Mixed-Methods Integration

The joint display in Table 5 integrates the quantitative and qualitative findings. The convergence between large vocabulary and inference effects and learners' reports of immediate feedback suggests that ELINA's strongest contribution was targeted subskill scaffolding. The small effect for overall comprehension is also consistent with learners' continued need for teacher-mediated discussion and interpretation. Because motivation and engagement were not tested as quantitative mediators, the mixed-methods interpretation remains explanatory rather than causal.

Table 5

Joint display of quantitative and qualitative findings

Finding area	Quantitative evidence	Qualitative evidence	Integrated interpretation
Vocabulary-in-context	Large experimental advantage, d = 1.47, p < .001	Learners valued glossaries, repetition, and immediate correction.	ELINA was effective for vocabulary because adaptive repetition and feedback directly matched the subskill demand.
Inferential comprehension	Large experimental advantage, d = 1.37, p < .001	Learners reported that guided prompts helped them infer meaning from context.	Inference benefited from structured questioning and staged SQ6R prompts.
Overall comprehension	Small, non-significant advantage, d = 0.20, p = .110	Learners still needed teacher explanation for complex interpretation.	Subskill gains did not fully transfer to holistic comprehension within the short intervention period.
Motivation and engagement	Not measured as a primary inferential outcome in this study	Learners reported higher motivation, persistence, and autonomy.	Affective and behavioral engagement may mediate longer-term gains and should be tested in future studies.
Blended implementation	ELINA group showed stronger targeted outcomes than control instruction.	Learners valued both adaptive practice and teacher support.	The system worked best as a complementary scaffold in blended learning.

5. Discussion

The findings indicate that integrating SQ6R into a personalized adaptive system can produce meaningful gains in selected reading subskills among intermediate EFL learners. The strongest effects were observed for vocabulary-in-context and inferential comprehension, whereas overall comprehension did not show a statistically significant between-group difference. This pattern is theoretically coherent because the responsive subskills can be supported through immediate feedback, repeated exposure, guided prompts, and individualized remediation. In other words, ELINA appears most effective where the learning target is specific, observable, and responsive to short-cycle feedback (Hattie & Timperley, 2007; Thakhulee et al., 2025).

The lack of a statistically significant difference in overall reading comprehension should not be interpreted as failure of the intervention. Rather, it suggests that holistic comprehension is a slower-developing outcome. Overall comprehension requires learners to integrate vocabulary, syntax, inference, cohesion, background knowledge, and discourse organization (Grabe & Stoller, 2019). These processes may not fully consolidate within a short intervention, even when subskills improve. This distinction prevents overclaiming and supports a more precise interpretation of the intervention effect.

From a sociocultural perspective, ELINA functioned as a digital scaffold within the learner's Zone of Proximal Development (Vygotsky, 1978). Learners received support

AITBSS
AI and Tech in Behavioral and Social Sciences
E-ISSN: 3041-9433

when they failed to meet mastery thresholds and were redirected to tasks that matched their current difficulty. From a cognitive-load perspective, the system may have reduced unnecessary burden by providing glosses, guided notes, and structured rereading activities, allowing learners to focus more directly on meaning-making (Sweller, 1988).

The qualitative findings strengthen this interpretation. Learners reported higher motivation, reduced anxiety, and increased autonomy, but they also emphasized the continued need for teacher mediation. This point is central to the contribution of the study. The results do not support a technology-replacement model. Instead, they support a blended model in which adaptive technology provides individualized practice and behavioral feedback, while the teacher remains responsible for explanation, interpretation, discussion, and affective support (VanLehn, 2011; Zimmerman, 2002).

The study also contributes to the scope of AI and technology in behavioral and social sciences by treating adaptive learning as a behavioral support system rather than merely a software tool. ELINA uses learner behavior--accuracy, time, repetition, and task completion--to guide instructional decisions. The learning-analytics contribution is therefore design-oriented and implementation-oriented rather than a full empirical analysis of learner interaction data (Kizilcec et al., 2013; Siemens & Baker, 2012).

6. Conclusion

This study provides post-intervention evidence that a rule-based adaptive system grounded in the SQ6R reading strategy can improve specific EFL reading subskills in a blended learning environment. ELINA produced large post-intervention advantages in vocabulary-in-context and inferential comprehension, while overall comprehension showed only a small and non-significant advantage. The qualitative evidence suggests that ELINA also supported motivation, perceived autonomy, engagement, and reduced reading anxiety. The main implication is that adaptive systems should be designed as pedagogically transparent scaffolds, not as substitutes for teacher expertise. For EFL reading instruction, the most defensible model is a blended one: adaptive technology supplies individualized feedback and remediation, while teachers guide higher-order comprehension and reflection.

7. Limitations and Future Directions

Several limitations should be acknowledged. First, the quasi-experimental design limits causal inference because full individual randomization was not feasible in the instructional setting (Creswell & Plano Clark, 2018). Second, although PET screening and a reading pretest were used procedurally, numerical baseline-equivalence statistics and baseline-adjusted analyses were not included. Third, the study focused on B1-level Iranian EFL learners, which limits generalizability to other proficiency levels and contexts. Fourth, the statistical design did not include more advanced analyses such as ANCOVA, growth modeling, mediation analysis, or learner-pathway modeling. Fifth, intervention dosage, ELINA-rule validation, questionnaire reliability, and qualitative trustworthiness procedures were limited in the present study. Sixth, the short intervention period may have been insufficient for subskill gains to transfer fully into overall comprehension.

Future studies should use longer intervention periods, delayed posttests, and complete item-level datasets. They should also report baseline equivalence, use baseline-adjusted models where possible, and analyze ELINA log data more systematically, including time-on-task, number of remediation events, pathway completion, and help-seeking behavior. A stronger future design would test whether motivation, feedback uptake, or self-regulated learning mediates the relationship between adaptive SQ6R instruction and reading outcomes. Comparative studies across proficiency levels and institutional contexts are also needed.

Authors' Contributions

All authors contributed to the study conception and design, data interpretation, manuscript preparation, and critical revision. All authors reviewed and approved the final version of the manuscript.

Declaration

A language model was used for language polishing, formatting consistency, and manuscript standardization. The authors remain fully responsible for the accuracy, integrity, and final scientific content of the manuscript.

Transparency Statement

The datasets used in the study are available from the corresponding author upon reasonable request, subject to

AITBSS
AI and Tech in Behavioral and Social Sciences
E-ISSN: 3041-9433

ethical and institutional restrictions. Shared platform-log datasets are anonymized and exclude identifiable learner records.

Acknowledgments

The authors thank the participating learners and instructors for their cooperation.

Declaration of Interest

The authors report no conflict of interest.

Funding

According to the authors, this article has no financial support.

Ethics Considerations

The study followed ethical principles for educational research involving human participants. Participants were informed about the purpose of the study, participation was voluntary, and all data were anonymized before analysis. ELINA-generated learner interaction logs were treated as confidential educational data.

References

Al-Jarf, R. (2021). Online technologies in English as a foreign language (EFL) instruction in Saudi Arabia. *Arab World English Journal*, *12*(2), 198-215. https://doi.org/10.24093/awej/vol12no2.14

Brown, H. D. (2014). *Principles of language learning and teaching* (6th ed.). Pearson. https://api.taylorfrancis.com/content/books/mono/download?identifierName=doi&identifierValue=10.4324/9781003494294&type=googlepdf

Chun, D. M., & Plass, J. L. (1996). Effects of multimedia annotations on vocabulary acquisition. *The Modern Language Journal*, *80*(2), 183-198. https://doi.org/10.1111/j.1540-4781.1996.tb01159.x

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates. https://api.taylorfrancis.com/content/books/mono/download?identifierName=doi&identifierValue=10.4324/9780203771587&type=googlepdf

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE. https://www.scirp.org/reference/referencespapers?referenceid=2697821

Grabe, W., & Stoller, F. L. (2019). *Teaching and researching reading* (3rd ed.). Routledge. https://doi.org/10.4324/9781315726274

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81-112.

Khodabakhshzadeh, H., Ghasemi, M., & Sahranavard, A. (2024). EFL teachers perception on the use of Twee for making English exams and tasks. *Transactions on Data Analysis in Social Science*, *6*(1), 11-21. https://doi.org/10.47176/TDASS.2024.11

Kizilcec, R. F., Piech, C., & Schneider, E. (2013). Deconstructing disengagement: Analyzing learner subpopulations in massive open online courses. Proceedings of the Third International Conference on Learning Analytics and Knowledge,

Robinson, F. P. (1941). *Effective study*. Harper & Brothers.

Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education. *International Journal of Artificial Intelligence in Education*, *26*(2), 582-599. https://doi.org/10.1007/s40593-016-0110-3

Siemens, G., & Baker, R. S. J. d. (2012). Learning analytics and educational data mining: Toward communication and collaboration. Proceedings of the 2nd International Conference on Learning Analytics and Knowledge,

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, *12*(2), 257-285. https://doi.org/10.1207/s15516709cog1202_4

Thakhulee, A., Sarnkong, R., & Athan, A. (2025). Using the SQ6R technique to enhance reading comprehension abilities for Thai 8th-graders. *Journal of Education and Learning*, *14*(6), 157-162. https://doi.org/10.5539/jel.v14n6p157

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist*, *46*(4), 197-221. https://doi.org/10.1080/00461520.2011.611369

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press. https://books.google.com/books?hl=en&lr=&id=RxjjUefze_oC&oi=fnd&pg=PA1&dq=Vygotsky,+L.+S.+(1978).+Mind+in+society:+The+development+of+higher+psychological+processes,+Harvard+University+Press.+%09&ots=okDVV5p_bu&sig=34ayJDBh51BwMpNLWPyhHxv7DPM

Wisniewski, B., Zierer, K., & Hattie, J. (2020). The power of feedback revisited: A meta-analysis of educational feedback research. *Frontiers in Psychology*, *10*, 3087. https://doi.org/10.3389/fpsyg.2019.03087

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education: Where are the educators? *International Journal of Educational Technology in Higher Education*, *16*, 39. https://doi.org/10.1186/s41239-019-0171-0

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory into Practice*, *41*(2), 64-70. https://doi.org/10.1207/s15430421tip4102_2

AITBSS
AI and Tech in Behavioral and Social Sciences
E-ISSN: 3041-9433