



SAGE: Addressing Gaps in User Understanding of Health Information with AI-Assisted Navigation of Knowledge Graphs

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OBJECTIVE

SAGE: System for Accessible Guided Exploration

- helps patients identify and fill gaps in their understanding of health information
- organizes information, generates guiding questions, and retrieves reliable responses
- merges LLMs' flexibility with knowledge graphs' reliability in this high-stakes domain

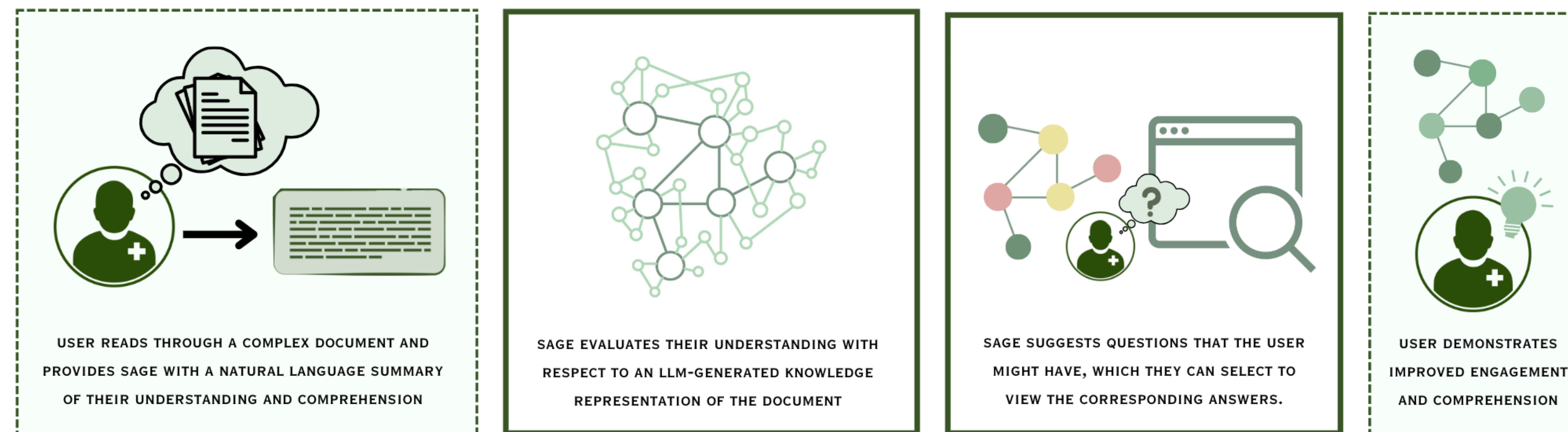


Figure 1: SAGE user interaction

SYSTEM DESIGN

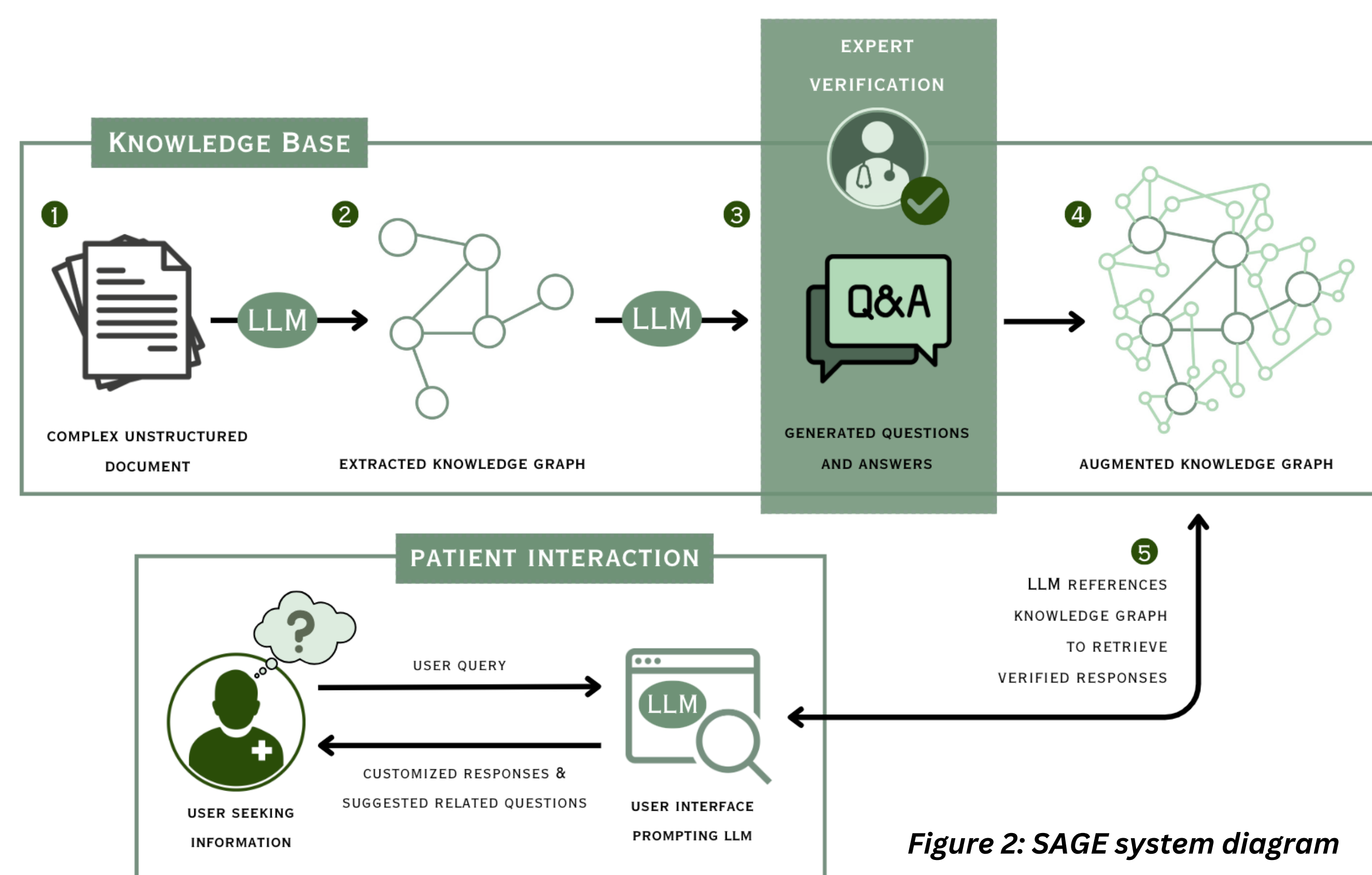


Figure 2: SAGE system diagram

Knowledge Gap Identification
SAGE mimics how physicians use teach-back methods to evaluate patient comprehension by assessing a natural language summary of their understanding.

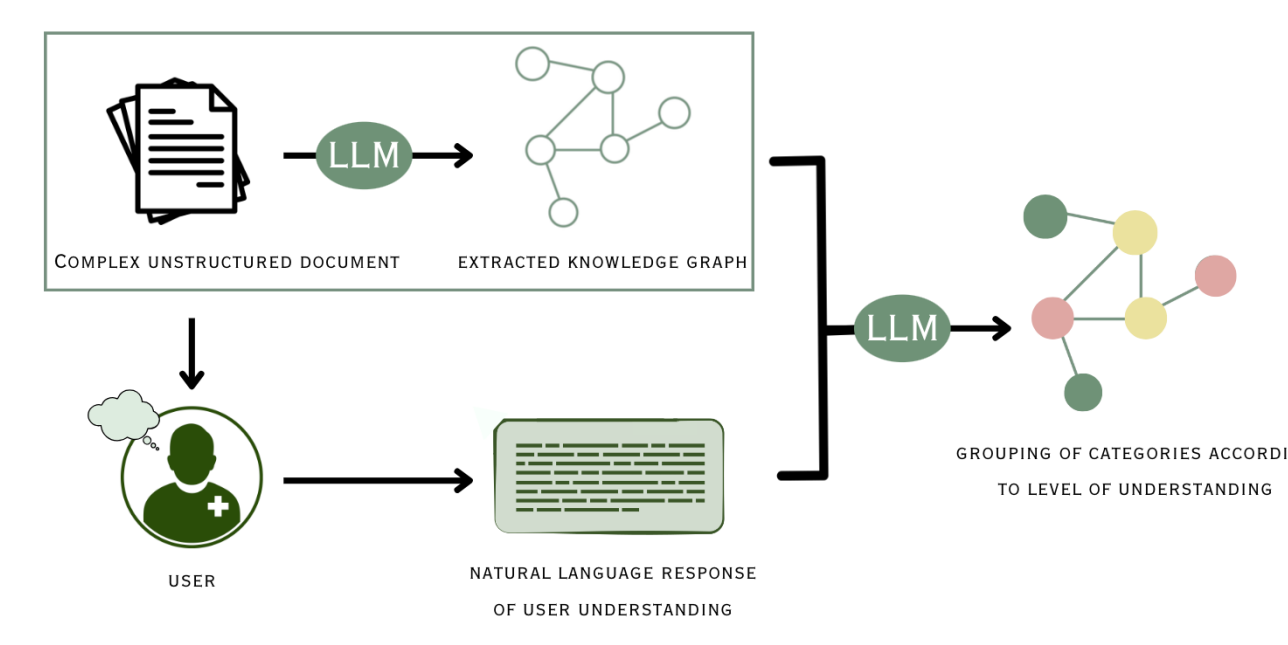


Figure 3: Identifying user knowledge gaps

Knowledge Graph Construction
Q&A pairs are generated using retrieval augmented generation (RAG) from verified patient education material, stored at various literacy levels. Vector similarities are calculated to connect nodes for traversal.

Knowledge Graph Traversal
SAGE tailors traversal of the KG, suggesting questions in areas of partial understanding to anchor new information, guiding users to new categories based on established comprehension. New relevant questions are suggested at each interaction.

EVALUATION METHODS

Evaluating self-reported health literacy

30 participants rated their ability to understand healthcare information by reviewing a synthetic diabetic foot ulcer diagnosis letter, noting initial questions, and comparing self-assessment to actual comprehension.

Evaluating SAGE's ability to accurately identify gaps in understanding
SAGE evaluated participants' understanding by asking them to summarize a provided letter using a teach-back strategy, then categorized their comprehension levels using the knowledge graph; participants validated these assessments.

Evaluating SAGE's ability to effectively fill knowledge gaps

Participants were guided through the knowledge graph via an intuitive Q&A interface to fill identified knowledge gaps, with personalized questions suggested based on gaps and iteratively updated, followed by a 10-minute independent exploration and a post-interaction comprehension survey.

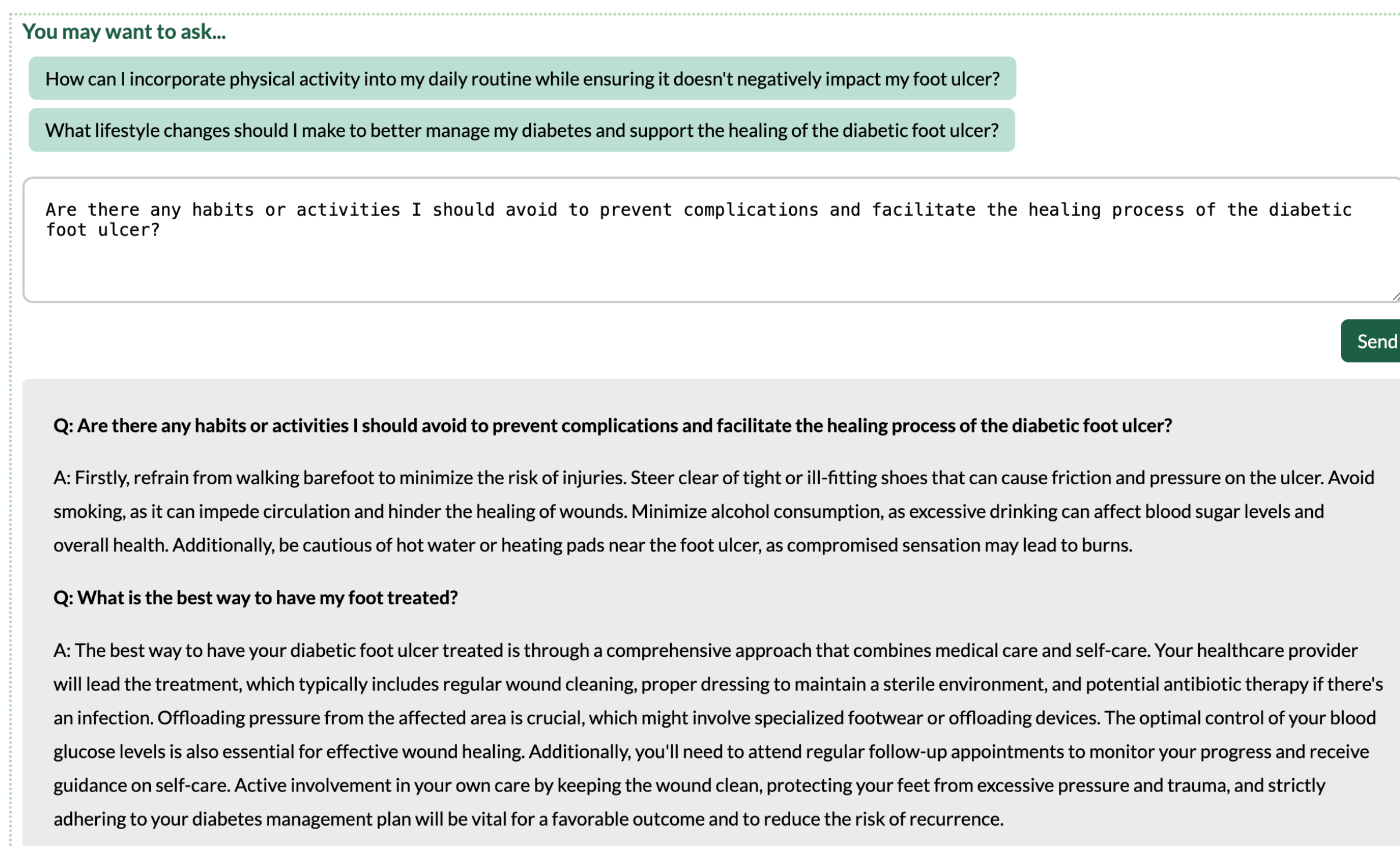


Figure 4: Addressing users' knowledge gaps through interactive Q&A

RESULTS

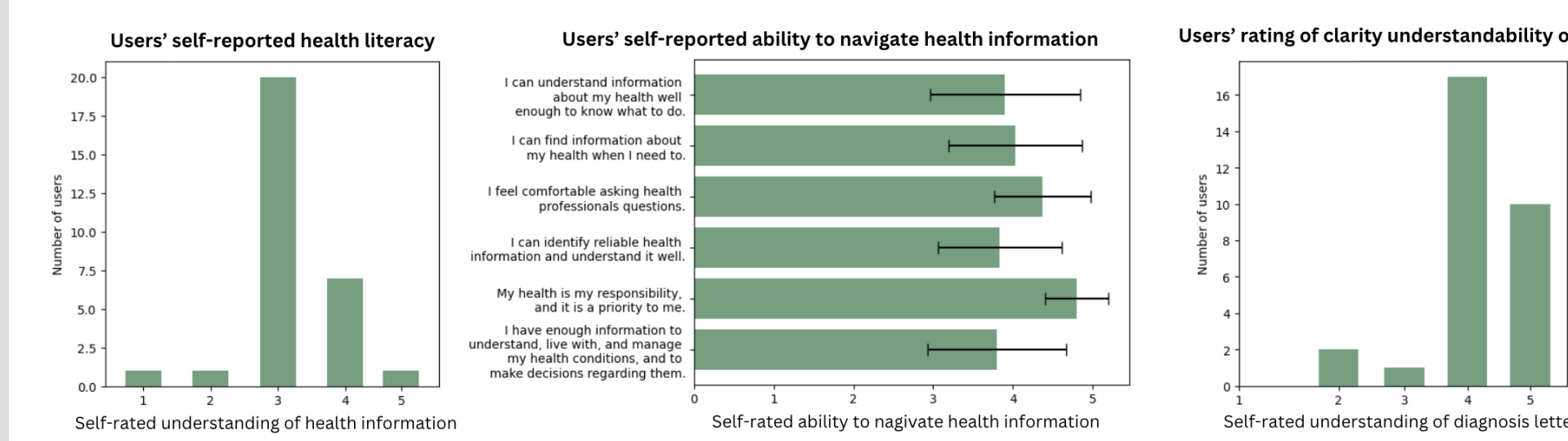


Figure 5: Users' self-reported health literacy

Self-reported health literacy lacks depth:
Vast majority of participants rated themselves as average or above, expressing high confidence in understanding the note, with few initial questions.

Identifying knowledge gaps reveals discrepancies in health literacy and diverse comprehension patterns:
SAGE's assessment of users' natural language summaries uncovered knowledge gaps acknowledged as accurate by nearly all.

	diagnosis	treatment	follow-up	symptoms	complications	prevention and self-care	monitoring	medication	clinical findings	tests	symptom management	lifestyle changes
p1				3			1					
p2		2		1			2			1	3	4
p3				2		1						
p4			3		1		4	1			2	5
p5				2		1					1	
p6				2		1		1				1
p7				2		1				3	1	
p8				2		1	1	1				1
p9												2
p10												3
p11				3	1			2		4		1
p12	1		3					1			2	1
p13				4	3					2		
p14				1								
p15				1	1							
p16	1			4	3					1	2	
p17		1	6	3	1							1
p18				1	2		1					3
p19				1	2					2		1
p20				3	2					2	2	
p21				1			3	2	1		1	4
p22				2	2							
p23				2								
p24	1		2	2	1							
p25				3	1			1	2	1		1
p26								1				2
p27				4	2							1
p28				1	1					1		
p29				1	3			2	2			2
p30	1	1	1	2			1					

Figure 6: Users' knowledge gaps and comprehension patterns

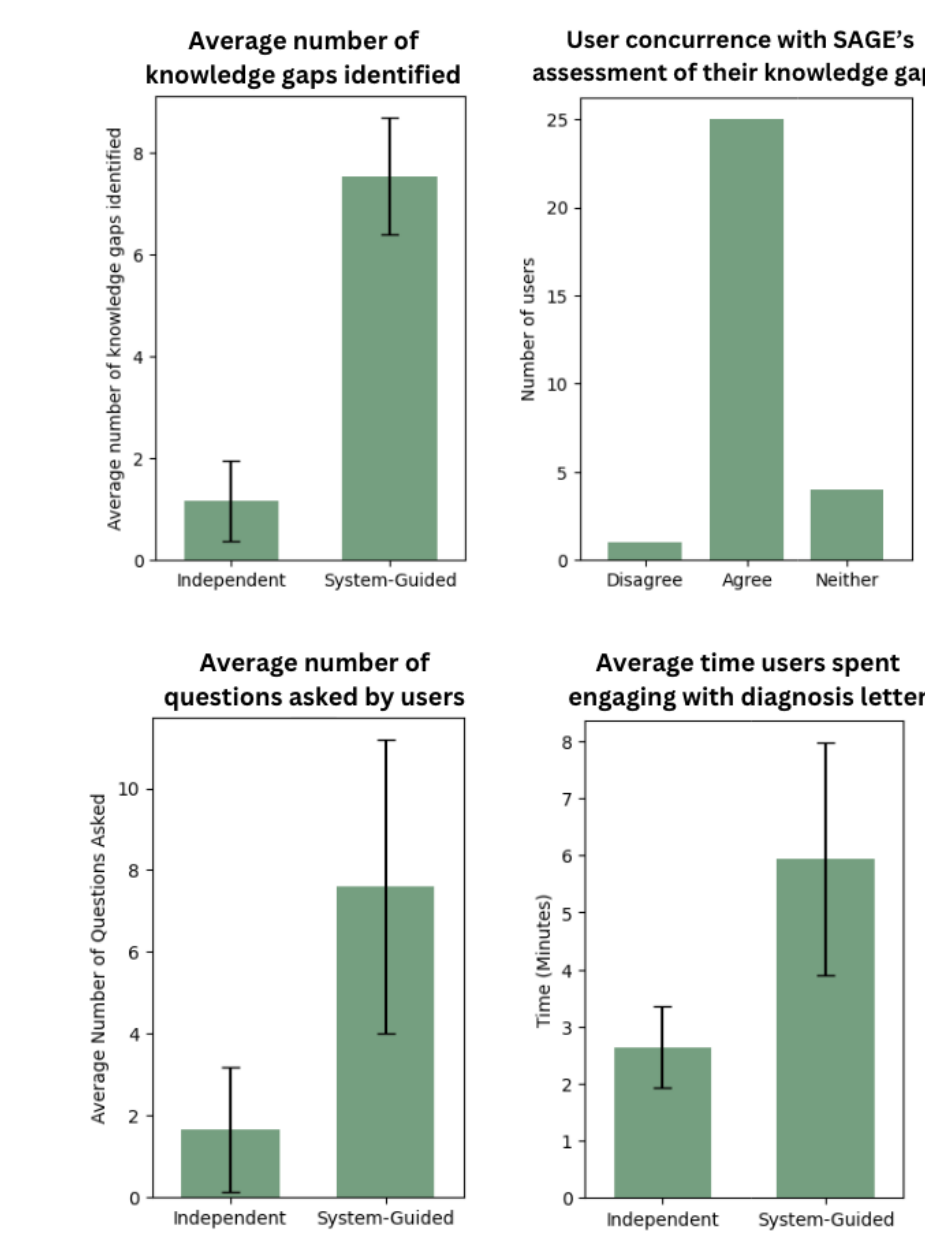


Figure 7: SAGE evaluation metrics

Guiding questions increase user engagement:

Interaction with SAGE led to a significant increase in participant-generated questions ($M = 7.60$, $SD = 3.64$) compared to independent questioning ($M = 1.67$, $SD = 1.56$, $t(29) = -8.2$, $p < .01$), and a significant increase in time engaging with the diagnosis letter and follow-up questions ($M = 5.94$, $SD = 2.03$) compared to initial engagement ($M = 2.64$, $SD = 0.72$, $t(29) = -8.3$, $p < .001$).

DISCUSSION

Human-AI Complementarity Enhancing Information-Seeking Behaviors

SAGE and similar tools can enhance understanding of novel, complex, or specialized knowledge, enriching comprehension and knowledge acquisition for users by detecting and filling knowledge gaps with complementary expertise.

Mutually Supportive Knowledge Models for Information Management and Retrieval

Various knowledge models can support, reinforce, and verify each other in practical applications. LLMs can construct KGs, and KGs verify LLM outputs, while LLMs aid in personalized delivery of information.

LLMs Promoting Information Equity and Democratizing Access to Knowledge

SAGE showcases how LLMs can provide tailored, accessible learning pathways and ensure proper information reception during self-directed learning.

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