Improving Consistency and Reliability in Patient-Facing Radiotherapy Education Using an AI Chatbot

Kay Li[1]; James Chow[1,2]
[1]University of Toronto, [2]Princess Margaret Cancer Centre

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ABSTRACT

Purpose
Patient-facing AI systems are increasingly used for education, yet their performance can vary widely depending on how users communicate. This study presents the development and evaluation of an AI-based chatbot designed to deliver consistent and reliable radiotherapy education across diverse real-world patient interactions using natural language processing.

Methods
A patient-facing chatbot was developed using the ChatGPT platform. It was configured for educational use through structured prompting and predefined response constraints. The system supports personalized dialogue, topic selection, and self-quizzes for learning reinforcement. Robust fallback mechanisms were implemented to manage ambiguous or unexpected inputs and maintain stable interactions across variable levels of health literacy and familiarity with radiotherapy. User feedback was collected using a 5-point Likert scale evaluating clarity, helpfulness, engagement, and overall satisfaction.

Results
The chatbot demonstrated strong performance as an educational support tool. Approximately 70% of users rated the chatbot above average for clarity, helpfulness, and appropriate reading duration. The adaptive dialogue structure sustained user engagement, while self-quizzes improved knowledge retention. Importantly, the system maintained consistent behavior across a broad range of user queries, supporting reliable information delivery in patient-facing contexts.

Conclusion
This work demonstrates that large language model–based chatbots can be configured to deliver reliable, patient-facing radiotherapy education when guided by structured design and interaction safeguards. The results highlight the potential for AI-driven educational tools to improve consistency in patient education and support scalable deployment in clinical environments.

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CONTACT

James Chow
Princess Margaret Cancer Centre, UHN
700, University Ave, Toronto
James.chow@uhn.ca
1 416 946 4501

INTRODUCTION

Patient education is a fundamental component of high-quality radiotherapy care, as patient understanding of treatment processes, safety considerations, and expected outcomes has been shown to influence engagement, satisfaction, and adherence. However, delivering consistent and comprehensive education remains challenging due to clinical time constraints, variability in verbal explanations, and differences in patient health literacy. Artificial intelligence assisted educational tools offer a potential solution by providing standardized, accessible, and on demand information. Early work has demonstrated the feasibility of developing AI assisted chatbots to support radiotherapy education using structured conversational platforms [1].More recently, large language model-based systems such as ChatGPT have enabled more natural and flexible interactions, allowing users to ask questions in their own words while still receiving accurate and context appropriate responses. At the same time, the deployment of large language model (LLM) based chatbots in healthcare introduces ethical considerations related to reliability, bias, and equitable information delivery, which must be addressed through careful system design and response constraints [2,3]. In this work, we developed and evaluated a patient facing radiotherapy educational chatbot designed for three user groups: patients, radiation oncology staff, and members of the general public. The goal was to provide clear and reliable educational content while maintaining conversational stability and supporting user engagement through structured dialogue and interactive learning.

METHODS AND MATERIALS

The radiotherapy education chatbot was implemented using the ChatGPT platform and configured specifically for educational use through structured system prompting and predefined response constraints, following previously described frameworks for ethical and controlled LLM deployment in healthcare education [2,3]. Educational content was curated and organized into topic-based modules covering key aspects of radiotherapy, including treatment planning, treatment delivery, safety considerations, and commonly asked patient questions. The chatbot interface initiated each session by greeting the user and presenting a structured list of radiotherapy related topics, allowing users to select areas of interest and navigate through the content in a guided but flexible manner, as illustrated in Figure 1. Personalization was incorporated by requesting a user provided name at the start of the interaction, which was then used throughout the conversation to create a more engaging and patient centered experience, as shown in Figure 2(a). To ensure robustness and conversational stability, the chatbot was designed with fallback mechanisms to address unclear, incomplete, or unexpected user inputs.

When ambiguity occurred, the chatbot prompted the user for clarification and provided contextual hints if necessary, as demonstrated in Figure 2(b). To reinforce learning and promote active engagement, self quiz questions were integrated at the completion of selected topic modules. When users provided incorrect responses, the chatbot delivered immediate explanatory feedback and guidance, as shown in Figure 2(c). User evaluation was conducted during the testing phase using a five-point Likert scale survey assessing content helpfulness, clarity of explanation, and appropriateness of reading duration, consistent with prior evaluations of radiotherapy educational chatbots [1].

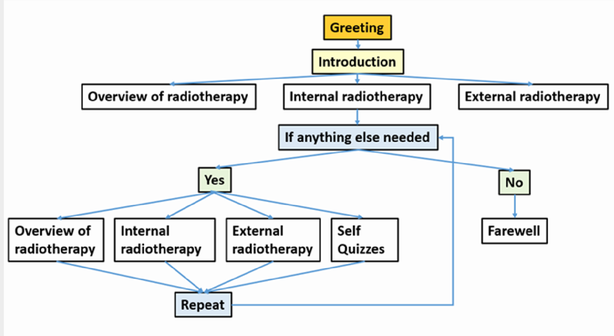

Figure 1. The flowchart of dialogue flow of the chatbot.

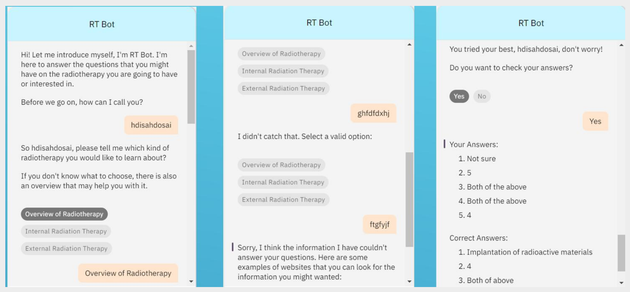

Figure 2. (a) Demonstration of calling user by input text; (b) demonstration of triggering fallback action and (c) preview of chatbot showing answer of self-quiz.

Table 1. Percentage of users' satisfaction on the contents of the chatbot.

Degree of Satisfaction (1 for lowest, 5 for highest)	Helpfulness of content	Understandability of content	Reading time length
1	5%	0%	0%
2	0%	15%	5%
3	25%	15%	25%
4	40%	40%	30%
5	30%	30%	40%

RESULTS

The chatbot demonstrated stable and coherent conversational performance across a wide range of user inputs, successfully guiding users through structured educational content while allowing them to control topic selection and session duration. The structured dialogue flow shown in Figure 1 prevented unbounded or irrelevant responses and ensured consistent information delivery. Fallback strategies effectively managed ambiguous user inputs and maintained conversational continuity without user frustration. The personalization features and interactive quiz elements further supported engagement and learning reinforcement.

User satisfaction survey results are summarized in Table 1. Approximately seventy percent of respondents rated the chatbot above average for content helpfulness, clarity, and reading duration. Users found the material easy to understand, appropriately paced, and relevant to their informational needs, with the self quiz features reinforcing key concepts through immediate feedback. Overall, the results indicate a positive and effective educational experience.

DISCUSSION

The findings of this study demonstrate that a carefully constrained LLM based chatbot can serve as a reliable and effective educational tool in radiotherapy. By combining structured dialogue flow with natural language interaction, the chatbot achieved a balance between flexibility and content control, which is critical in healthcare education applications. The dialogue framework shown in Figure 1 was essential for maintaining consistency and preventing conversational drift, while the clarification and fallback mechanisms illustrated in Figure 2 reduced the risk of miscommunication and misinformation. The favorable user satisfaction results shown in Table 1 are consistent with previous studies demonstrating the potential of AI assisted chatbots to enhance radiotherapy education [1]. Importantly, this work extends prior efforts by leveraging LLM based technology while explicitly incorporating ethical design principles and bias mitigation strategies described in recent literature [2,3]. Designing the chatbot to serve multiple user groups required careful attention to communication style and informational depth, highlighting the importance of adaptable yet controlled response generation. Future work will focus on evaluating long term knowledge retention, usability in clinical workflows, and the impact of such tools on patient equity and access to information.

CONCLUSIONS

A patient facing radiotherapy education chatbot using artificial intelligence and natural language processing was successfully developed and evaluated. The chatbot delivered structured, clear, and engaging educational content and achieved high user satisfaction across multiple evaluation metrics. The integration of guided topic selection, clarification handling, personalization, and self assessment quizzes supports its potential as a scalable supplement to clinician led education. With continued refinement and validation, LLM based chatbots may play an important role in improving consistency, accessibility, and quality of radiotherapy education in clinical practice.

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