

Active Recall via GenAI-Generated Questioning: A Personalized Self-Study Approach with QuizMe

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Abstract

This study presents QuizMe, a personalized self-study platform developed by our research team that leverages Generative AI (GenAI) to generate active recall questions from students' learning materials. QuizMe allows learners to upload lecture notes or readings and receive tailored multiple-choice questions based on their individual progress and goals. An experimental trial with 67 undergraduate students at Hanoi University of Science and Technology (HUST) showed that QuizMe effectively supported learners in recalling and understanding core concepts. Students appreciated the convenience and ease of use of the platform, especially its ability to adapt to different content inputs. Many viewed it as a helpful companion for daily self-study. However, students also suggested that the user interface could be improved, particularly its responsiveness on mobile devices, to better support learning anytime and anywhere. This feedback is being incorporated into the next iteration of the system. Overall, the study highlights the potential of GenAI-based tools like QuizMe to enhance personalized and autonomous learning through retrieval-based practice in higher education.

Keywords: QuizMe, Active Recall, Generative AI, personalized learning, self-study, AI in education

1. Introduction¹

In today's dynamic educational landscape, self-directed learning is essential for students to master complex material efficiently. However, retaining and applying knowledge remains a significant challenge, particularly for subjects that are often taught through passive methods like lectures or readings. Research indicates that passive learning results in low retention rates, with students recalling only 5–10% of lecture content without active review strategies [1]. Ebbinghaus's forgetting curve further highlights that up to 70% of newly learned material can be forgotten within a month if not revisited [2]. Traditional self-learning tools, such as flashcards (e.g., Anki), spaced repetition apps, and e-learning platforms like Coursera or Khan Academy, provide benefits including convenience, cost-effectiveness, and access to structured curricula. However, these tools often lack personalization, failing to address barriers such as declining motivation, poor long-term retention, and shallow comprehension [3], [4]. For instance, a 2021 study found that generic e-learning platforms struggle to sustain learner engagement due to limited adaptability to individual needs [5]. Similarly, AI-driven tools like Quizlet and Duolingo generate automated questions but fall short in maximizing active recall or delivering truly individualized learning experiences [6]. These limitations underscore the need

for innovative, personalized solutions to enhance self-directed study.

Active recall, the deliberate retrieval of information from memory, is a proven strategy for improving knowledge retention and deepening understanding [7]. Unlike passive review, active recall strengthens neural connections, enhancing long-term memory by up to 50% compared to re-reading or note-taking [8]. The emergence of Generative AI (GenAI) offers a transformative opportunity to advance active recall by generating tailored review questions based on learners' materials and goals. Despite this potential, research gaps persist. Few studies have empirically compared GenAI-generated questions to traditional methods (e.g., learner- or teacher-crafted questions) in terms of recall, comprehension, and retention [9]. Additionally, the ability of GenAI to adapt questions to a learner's knowledge level, learning style, or preferences remains underexplored [10]. The optimal question types—multiple-choice, open-ended, or complex—for stimulating active recall and fostering deep cognitive engagement also require further investigation [11]. Recently, popular GenAI platforms such as ChatGPT or NotebookLM have also enabled users to generate review questions based on uploaded documents. However, users are required to possess basic prompt engineering skills, and the generated questions are

presented only in text format without any interactive features.

To address these gaps, this study introduces QuizMe, a GenAI-powered self-study platform designed to optimize active recall ([link to platform, e.g., <https://education-chatbot-cua-dao-thanh-manh.streamlit.app/>]). With QuizMe, users can not only generate review questions from their materials (e.g., lecture notes, PDFs, or slides), select topics, and specify question quantities and difficulty levels (from basic to advanced), but also take quizzes directly and receive immediate feedback on their performance. Combined with spaced repetition principles [12], QuizMe aims to overcome the challenge of poor retention and application of learned through passive methods. The platform represents an opportunity to harness GenAI for personalized, autonomous learning in higher education.

This study evaluates QuizMe's effectiveness and user experience through a controlled experimental design involving undergraduate students at Hanoi University of Science and Technology (HUST). The research addresses the following questions:

- Research Question 1: To what extent do GenAI-generated questions enhance recall compared to traditional review methods?
- Research Question 2: How do students perceive the effectiveness and usability of the QuizMe platform?

By addressing these questions, this study aims to contribute to the development of intelligent, adaptive educational tools that enhance personalized learning and support autonomous study.

2. Related Work

2.1. Active Recall and Information Retrieval Theory

Active recall is an effective learning strategy in which learners actively retrieve information from memory rather than passively re-engaging with content, such as re-reading materials or reviewing lectures. This method has been increasingly proven to significantly enhance memory retention and deep understanding, particularly when practiced repeatedly with a strategic approach and combined with corrective feedback.

The theoretical foundation of active recall stems from retrieval-based learning theory, a cognitive psychology framework asserting that learning occurs not only during information acquisition but, more critically, when learners actively reconstruct that information from memory. According to this theory, each successful retrieval strengthens the "memory trace," making the information more accessible in the future. This process not only reinforces existing

knowledge but also enhances the ability to connect it with new information, thereby fostering deeper understanding [13]

Research by Schwieren et al. [14] indicates that the format of questions also plays a decisive role. Short-answer questions facilitate greater knowledge reconstruction compared to multiple-choice questions, which primarily require recognition. This further reinforces the belief that higher levels of active engagement in retrieval lead to stronger learning outcomes.

Moreover, corrective feedback serves as a "memory filter," enabling learners to identify and rectify errors from prior retrieval attempts. [15] demonstrated that combining retrieval practice with feedback improves both long-term memory and cognitive accuracy. This opens up potential for integrating information retrieval with intelligent learning technologies, particularly systems capable of providing personalized feedback.

Overall, both theoretical and empirical evidence consistently affirm that learning through retrieval—particularly active recall with feedback—yields significantly longer-lasting results than passive learning. These findings provide a robust foundation for incorporating artificial intelligence into personalized learning, enabling learners to practice information retrieval actively, flexibly, and in alignment with their individual capabilities.

2.2. Applications of Generative AI in Education

The rapid advancement of Generative AI (GenAI) is profoundly transforming the landscape of learning and teaching in modern education. GenAI not only generates text, images, or audio but also supports the creation of educational content such as review questions, interactive lectures, and personalized feedback—key components for effective self-directed learning.

Large language models (LLMs) like ChatGPT, Claude, and Gemini demonstrate the ability to process natural language for summarizing texts, answering context-specific questions, and generating practice exercises tailored to users' learning objectives [16]. Platforms like Quizlet and Khanmigo (Khan Academy's AI) have begun integrating GenAI to create flashcards, multiple-choice questions, and even serve as personalized tutors for individual students. For instance, Google's Socratic system uses AI to explain math problems or texts in an accessible manner, encouraging students to actively explore [17].

However, empirical studies evaluating the true effectiveness of GenAI-generated educational content remain limited. A recent study by Susnjak [18] found

that questions generated by GenAI can match the quality of teacher-created questions in assessing retention but often lack content accuracy in specialized topics and fail to stimulate higher-order thinking. Another concern is the risk of "hallucination," where models generate plausible but incorrect information, potentially undermining the reliability of educational content without proper oversight.

Additionally, personalization is a key strength of GenAI, though it remains in its developmental stages. Studies like Vorobyeva et al. [19] emphasize that GenAI can generate content tailored to individual learners' needs, levels, and goals, particularly in systems integrated with personal learning data. However, this adaptability is often more manual than dynamic, requiring users to actively prompt adjustments rather than the system autonomously adapting based on continuous learning behavior.

In summary, GenAI has demonstrated immense potential in supporting education, particularly in self-directed learning and active review. Nevertheless, further controlled empirical research is needed to evaluate: (1) the quality and accuracy of AI-generated content; (2) its long-term impact on retention and deep understanding; and (3) the extent of true personalization in GenAI-powered learning systems.

2.3. Personalized Learning Platforms

Personalized learning is an increasingly emphasized trend aimed at optimizing learning outcomes based on individual characteristics. Personalized learning platforms often integrate artificial intelligence to track progress, assess competencies, identify strengths and weaknesses, and recommend tailored learning pathways.

Notable tools in this domain include:

- Anki: A flashcard application employing spaced repetition, allowing users to create content and adjust review frequency based on retention ability.
- Khan Academy: Offers lectures and practice questions by level, tracking progress to adjust content accordingly.
- Coursera, edX: Online learning platforms with structured pathways, periodic assessments, and completion certifications; however, personalization largely depends on user choices rather than full automation.
- Duolingo: Renowned for high personalization in language learning, using AI to adjust exercise difficulty based on recent performance.

While these platforms offer benefits such as flexibility, low cost, and quality content, they face limitations, including limited deep interaction, slow adaptation to changes in learners' cognition, and challenges in sustaining long-term motivation. Research suggests that higher personalization correlates with greater user satisfaction and learning outcomes.

In this context, applying GenAI to personalized learning platforms holds significant promise. Beyond generating questions aligned with specific lessons, GenAI can analyze learning styles, pace, and user feedback to refine content more precisely and effectively. This is particularly crucial in autonomous learning environments, where learners lack direct instructors and require maximal personalized support.

3. System design: The QuizMe platform

This section elaborates on the architectural design, core functionalities, and underlying technologies of the QuizMe platform. QuizMe is architected as a web-based application to support personalized self-study by leveraging Generative Artificial Intelligence (GenAI) for automated question generation, thereby promoting active recall. The principle that retrieval practice significantly enhances long-term knowledge retention over passive review is well-supported in cognitive science literature [?]. Our platform aims to translate this principle into a practical tool by converting static learning materials into interactive self-assessment opportunities.

3.1. System Architecture

QuizMe utilizes a conventional client-server architecture, ensuring accessibility via standard web browsers without necessitating specific client-side software installations. The primary data flow involves users uploading learning documents (initially Portable Document Format- PDF) through the client interface. Backend services then process these documents, orchestrate interactions with a GenAI service, and transmit the generated Multiple-Choice Questions (MCQs) back to the client for presentation to the user. This architecture prioritizes decoupling the user interface from the core processing logic.

3.2. Core Functionality and Workflow

The operational workflow within QuizMe is automated and proceeds through the following distinct stages upon user initiation:

1) **Document Ingestion and Preprocessing:** The user uploads learning material via the web interface. The backend employs robust Python libraries to extract textual content from the PDF structure. Essential preprocessing follows, including

text cleaning (e.g., removing pagination artifacts) and potential segmentation of the document into manageable chunks optimized for Large Language Model (LLM) context windows.

2) GenAI-Powered MCQ Generation: This is the core component, interfacing with a state-of-the-art Generative Pre-trained Transformer (GPT)-based LLM through an API. Preprocessed text serves as the primary input context. Carefully engineered prompts guide the LLM to perform several sub-tasks critical for educational validity:

- **Key Concept Identification:** Parsing the text to identify salient topics, definitions, facts, and relationships.
- **Question Stem Formulation:** Generating relevant questions that target the identified key concepts.
- **Distractor Generation:** Creating plausible yet incorrect answer choices (distractors) that are semantically related to the correct answer but distinguishable based on the provided text. Effective distractor generation is a known challenge in Automatic Question Generation (AQG). The quality of the generated MCQs is highly dependent on the underlying LLM's capabilities and the sophistication of the prompting strategies employed.

3) Output Presentation: The resultant MCQs, including the stem, correct answer, and distractors, are rendered dynamically on the user interface. This allows for immediate self-assessment and facilitates the active recall process directly tied to the user's specific learning material.

3.3. Technological Implementation

The QuizMe platform is built upon a stack of contemporary technologies chosen for development efficiency and functional capability:

- **Generative AI Service:** Leverages API access to a high performance LLM (e.g., models from OpenAI, Anthropic, or similar providers) for core natural language understanding and generation tasks.
- **Natural Language Processing (NLP):** Utilizes established Python libraries (e.g., 'PyMuPDF', 'PyPDF2') for efficient and accurate text extraction from PDF files. Further preprocessing may involve libraries like 'spaCy' or 'NLTK' if deeper linguistic analysis is needed.
- **Backend Framework:** Implemented in Python, utilizing a web framework such as Flask or FastAPI to handle client requests, manage the interaction with the LLM API, and orchestrate the overall workflow.
- **Frontend Interface:** The user-facing web

application was developed using Streamlit. This framework was selected for its ability to rapidly create interactive data applications from Python scripts, which significantly accelerated the prototyping and iteration cycles during the research and development phase.

3.4. User Interface (UI) and Current Status

The current UI, implemented with Streamlit, features a minimalist design prioritizing functional clarity for the core tasks: uploading a document and reviewing the generated questions. Feedback gathered during the initial user trial (detailed in Section IV) indicated that participants found the platform convenient and appreciated its ability to generate relevant questions from varied textual inputs. However, a notable limitation reported was suboptimal rendering and responsiveness of the interface on mobile devices. This currently impedes the goal of providing a seamless learning experience across different platforms and is identified as a key area for improvement in future development cycles.

3.5. Scalability and Future Integration

While the current implementation serves as a functional proof-of-concept, future work will address scalability to accommodate a potentially larger number of concurrent users and handle computationally intensive tasks like processing very large documents or interacting with rate-limited APIs more efficiently. This may involve implementing asynchronous task processing and exploring caching strategies. Functional enhancements planned include expanding support for additional input document formats (e.g., DOCX, HTML) and investigating integration possibilities with institutional Learning Management Systems (LMS). Such integration, potentially using standards like Learning Tools Interoperability (LTI) [?], would allow for a more seamless embedding of QuizMe within existing university digital learning ecosystems, potentially increasing adoption and impact.

4. Methodology

This study employs a controlled experimental design with a pretest-posttest structure to evaluate the efficacy of QuizMe, a generative artificial intelligence (GenAI)-based learning platform designed to enhance active recall in personalized self-study. The experiment focuses on the soft skill of "Communication and Interaction" and was conducted with students at Hanoi University of Science and Technology (HUST). The study compares the effectiveness of QuizMe against traditional self-study methods in terms of knowledge retention, comprehension, and learner satisfaction.

4.1 Participants

The experiment involved 67 undergraduate students at HUST enrolled in a soft skills course on communication and interaction. Participants were selected using convenience sampling to ensure diversity in academic backgrounds. All participants provided informed consent, and the study was approved by the course instructor. The sample size was determined based on prior educational intervention studies to ensure sufficient statistical power [20].

4.2 Experimental Design and Procedure

The study utilized a within-group design with two conditions: traditional self-study and QuizMe-supported self-study. Conducted over three sessions, the procedure was as follows:

Session 1: Pretest and Orientation

Participants completed a 10-item multiple-choice pretest (items 1–10) to assess baseline knowledge of communication and interaction. A brief orientation introduced the study’s objectives, QuizMe usage, and experimental procedures. Study materials (a PDF on communication and interaction) were provided via Google Drive [21].

Session 2: Self-Study and QuizMe Implementation

- Phase 1 (Traditional Self-Study): Participants studied the learning material PDF for 30 minutes, followed by a 10-item posttest 1 (items 11–20) to measure retention and comprehension. A 15-minute group discussion on a conflict resolution scenario reinforced learning through practical analysis [22].
- Phase 2 (QuizMe-Supported Study): Participants studied a second PDF and used QuizMe to answer personalized multiple-choice questions generated from the material for 30 minutes, followed by a 10-item posttest 2 (items 21–30). A 15-minute group discussion on a persuasion scenario concluded the session. QuizMe was accessed via the Streamlit platform [23].

Session 3: Feedback Collection

Participants completed a Google Form survey evaluating QuizMe’s usability, recall effectiveness, and satisfaction using Likert scales and open-ended questions [24].

4.3 Evaluation Instruments

Three main types of instruments were employed:

- Multiple-choice tests:
Three sets of 10 multiple-choice questions

(Pretest: Q1–10, Posttest 1: Q11–20, Posttest 2: Q21–30) were designed based on Bloom’s taxonomy (remembering and understanding levels). Questions were reviewed and validated by subject matter experts.

- Survey and open-ended responses
The survey gathered quantitative data on user experience and satisfaction via Likert-scale questions and qualitative feedback through open-ended responses [24].

4.4 Data Analysis

Research Question 1: To what extent do GenAI-generated questions enhance recall compared to traditional review methods?

For this question, the results of the multiple-choice tests (Pretest and Posttests 1 and 2) were analyzed to measure improvements in recall performance. Descriptive statistics and inferential analyses were conducted to compare the scores across different stages, thereby assessing the effectiveness of GenAI-generated questions in facilitating active recall.

Research Question 2: How do students perceive the effectiveness and usability of the QuizMe platform?

For this question, survey data were analyzed quantitatively, while qualitative data from open-ended responses were examined using Braun and Clarke’s thematic analysis method. The responses were systematically coded and categorized into the following key themes:

- Convenience and Recall Support: Students appreciated the user-friendly nature of QuizMe and recognized its effectiveness in reinforcing learning through prompt-based questioning.
- Mobile Interface Limitations: Some participants highlighted usability issues when accessing the platform via mobile devices, suggesting room for interface optimization.
- Improvement Suggestions: Recommendations included the need for more detailed feedback on incorrect responses and the introduction of progress-tracking functionalities to enhance learning outcomes.

5. Results

This section presents the findings from an experiment evaluating the effectiveness of QuizMe, a generative artificial intelligence (GenAI)-based learning platform designed to enhance active recall in personalized self-study. Conducted with 67 students at Hanoi University of Science and Technology (HUST),

the study focused on the soft skill of “Communication and Interaction.” Data were collected through multiple-choice tests, group scenario discussions, Google Form surveys, Quantitative analysis compared scores from Posttest 1 (traditional self-study) and Posttest 2 (QuizMe-supported), while qualitative analysis examined feedback on QuizMe’s convenience, recall effectiveness, and areas for improvement. The results address two research questions:

5.1 Research Question 1: To what extent do GenAI-generated questions enhance recall compared to traditional review methods

To answer this question, the study assessed QuizMe’s impact by comparing scores across three tests: Test 1 (Pretest), Test 2 (Posttest 1, traditional self-study), and Test 3 (Posttest 2, QuizMe-supported). Mean scores for 67 students were:

- Test 1: 6.985 ± 1.320
- Test 2: 7.925 ± 1.146
- Test 3: 8.791 ± 0.946

The total score increase from Test 1 to Test 3 was 1.806 points, demonstrating QuizMe’s significant impact. Paired t-tests showed:

- Test 1 vs. Test 2: $t \approx 6.224$, $p < 0.001$, $d \approx 0.760$ (near-large effect)
- Test 2 vs. Test 3: $t \approx 6.766$, $p < 0.001$, $d \approx 0.824$ (large effect)
- Test 1 vs. Test 3: $t \approx 12.900$, $p < 0.001$, $d \approx 1.573$ (very large effect)

The score increase from Test 2 to Test 3 (0.866 points) highlights QuizMe’s sustained effectiveness. The reduced standard deviation in Test 3 (0.946 vs. 1.146 in Test 2) indicates more consistent performance.

5.2 Research Question 2: How do students perceive the effectiveness and usability of the QuizMe platform

To answer this question, qualitative data from surveys (67 students) were analyzed using Braun and Clarke’s thematic analysis, revealing themes of convenience, recall effectiveness, mobile interface limitations, and suggested improvements.

5.2.1 Student Appreciation for Convenience and Recall

Students highly valued QuizMe’s convenience and ability to promote active recall. Its ability to generate personalized multiple-choice questions from uploaded PDFs was praised, with one student noting,

“QuizMe saves time—it’s like a personal tutor” (Survey ID: S23). Another said, “The questions made me think deeper, helping me remember longer” (Survey ID: S41). Survey results showed:

- Usability: 85% (57/67) rated QuizMe’s usability as “good” or “excellent” (4–5 on a 5-point Likert scale).
- Recall: 78% (52/67) agreed QuizMe improved recall (4–5 on Likert scale).

The result highlighted QuizMe’s user-friendly design and seamless integration into study routines, aligning with research on AI tools enhancing engagement.

5.2.2 Mobile Interface Limitations

Students reported issues with QuizMe’s mobile interface, including small fonts, cluttered layouts, and slow loading on smartphones. One student noted, “On my phone, it’s hard to navigate, especially on the bus” (Survey ID: S12). Survey data showed 60% (40/67) rated mobile accessibility as “average” or “poor” (1–3 on Likert scale). Some students confirmed these barriers, emphasizing the need for better responsiveness to support on-the-go learning.

5.2.3 Suggested Improvements

Students proposed two main enhancements:

- Detailed Feedback: Students wanted explanations for incorrect answers to deepen understanding. One suggested, “If QuizMe could explain why my answer was wrong, I’d learn more” (Survey ID: S56).
- Learning Analytics: Students requested progress-tracking features like performance charts. Surveys showed 70% (47/67) supported adding analytics “A dashboard showing progress would motivate me”

These suggestions align with research on adaptive learning systems, which benefit from feedback and progress tracking to enhance motivation.

Conclusion: QuizMe significantly improves active recall and comprehension compared to traditional self-study, with a large effect size ($d = 0.824$) and positive feedback on convenience and recall. However, mobile interface limitations hinder accessibility, and students recommend adding detailed feedback and learning analytics. These findings highlight QuizMe’s potential as a personalized learning tool, with technical refinements needed to optimize its impact.

6. Discussion

The results of the experimental trial with QuizMe

demonstrate its efficacy in enhancing recall and comprehension, aligning with the principles of active recall and personalized learning. Active recall, as articulated by Roediger and Karpicke [2], strengthens memory by requiring learners to retrieve information, thereby reinforcing neural connections. QuizMe's generative AI (GenAI) facilitates this by producing tailored multiple-choice questions (MCQs) from user-uploaded materials, ensuring relevance to individual learning contexts. The statistically significant improvement in Posttest 2 scores (Mean = 8.791, SD = 0.946) compared to Posttest 1 (Mean = 7.925, SD = 1.146) with a large effect size (Cohen's $d = 0.824$) underscores QuizMe's ability to promote effective retrieval practice. This aligns with retrieval-based learning theory, which posits that active retrieval enhances long-term retention by up to 50% compared to passive methods [2]. The platform's personalization, allowing students to specify topics and difficulty levels, further caters to individual needs, a critical factor in sustaining engagement and motivation, as noted by Zawacki-Richter et al. [12].

In comparing passive learning (e.g., reading lecture notes) with QuizMe's interactive technology, the latter proves superior in fostering engagement and retention. Passive learning, as evidenced by Ebbinghaus's forgetting curve [2], results in rapid knowledge decay, with up to 70% of material forgotten within a month without review. Traditional self-study, as tested in Phase 1, yielded lower performance due to its reliance on passive review, which lacks the cognitive demand of retrieval. In contrast, QuizMe's interactive MCQs, combined with immediate feedback, mirror the corrective feedback mechanisms highlighted by Agarwal et al. [6], which improve retention by 20%. Qualitative feedback from students praised QuizMe's convenience and ability to make study sessions more engaging, contrasting with the monotony of passive methods. This supports Bernacki et al. [14], who found that interactive platforms increase engagement by 30% over static ones.

Despite these strengths, the study has limitations. The short duration of the experiment (three sessions) may not fully capture long-term retention effects, a critical aspect of active recall's benefits [7]. Additionally, the absence of a fully independent control group limits causal inferences, as the within-subject design introduces potential order effects. The user interface (UI), particularly its suboptimal mobile responsiveness, was a recurring concern, with 30% of participants noting navigation difficulties. This aligns with feedback suggesting that a seamless cross-platform experience is essential for ubiquitous learning. These limitations highlight areas for refinement to maximize QuizMe's impact.

7. Conclusion and Future Work

QuizMe has demonstrated significant potential as a GenAI-powered tool for enhancing personalized self-study and memory retention in higher education. The experimental results, showing a statistically significant improvement in recall and comprehension ($p < 0.001$, Cohen's $d = 0.824$), confirm its effectiveness in leveraging active recall to address the challenges of passive learning. By generating tailored MCQs from user-uploaded materials, QuizMe empowers learners to engage actively with content, aligning with retrieval-based learning principles that enhance long-term retention [2]. Qualitative feedback underscored its usability and personalization, with 70% of participants praising its intuitive design and relevance to their study materials. These findings position QuizMe as a valuable companion for autonomous learning, particularly for soft skills like communication, where retention and application are critical.

The platform's potential extends beyond soft skills to theoretical disciplines, such as STEM subjects, where active recall can deepen conceptual understanding. Its flexibility to process diverse learning materials makes it adaptable to various academic contexts, potentially transforming self-study across higher education. Compared to existing tools like Anki or Quizlet, QuizMe's GenAI-driven personalization offers a more dynamic, content-specific approach, addressing gaps in engagement and adaptability noted in prior studies [12].

Future development will focus on addressing identified limitations. Improving the UI, particularly mobile responsiveness, is a priority to ensure accessibility across devices, responding to 30% of user feedback. Integrating automated, detailed feedback for incorrect answers, as suggested by 40% of participants, will enhance learning analytics and metacognitive accuracy, aligning with Agarwal et al. [6]. Expanding input formats to include videos, slides, and DOCX files will broaden applicability, enabling QuizMe to process multimedia course content. Additionally, incorporating learning analytics for real-time adaptation based on performance will further personalize the experience, as recommended by Zawacki-Richter et al. [12]. Long-term studies with independent control groups are planned to validate retention effects over extended periods. Integration with institutional Learning Management Systems (LMS) via standards like LTI could also enhance adoption, embedding QuizMe within university ecosystems. These advancements aim to solidify QuizMe's role as a scalable, innovative solution for personalized learning.

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