# GoalViz: A Generative AI Framework for Adaptive, Goal-Driven Narrative Health Education

## 1 Project Description

Effective patient education is essential for informed decision-making, treatment adherence, and health outcomes. Yet most materials remain static, generic, and disconnected from the personal goals that shape how patients understand and act on medical advice. As more patient-generated content flows through secure messaging platforms, we have a unique opportunity to align education with patient-defined needs.

This project proposes GoalViz, a generative AI system for personalized, goal-driven health education using interactive visual narratives. For example, a breast cancer patient experiencing treatment-related fatigue may message their provider: "I just want the energy to play with my child again." GoalViz transforms this goal into a symbolic visual journey, framed as a visual novel–style experience, where the patient explores self-care strategies through interactive dialogue and metaphorical scenes. The narrative adapts to their context, using visuals and conversation to convey medical knowledge and foster self-efficacy.

The system is intended for patients navigating complex or emotionally demanding conditions (e.g., cancer), especially when information is delivered asynchronously and may be difficult to retain. Clinicians, educators, and health communicators can use GoalViz to augment traditional education with interactive tools that better reflect patient goals and values. Technically, the system integrates LLM-based goal extraction, controllable narrative generation, and visual synthesis via vision-language models. Symbolic metaphors and dialogue-based interactions promote clarity, motivation, and emotional engagement. This project advances scalable, human-centered, value-aligned AI for healthcare. It contributes both methodological innovation in generative AI and practical impact through adaptive, personalized communication tools.

### 1.1 Motivation and Background

Patient education is essential for informed decision-making and improved health outcomes. Yet most existing materials remain static, text-heavy, and poorly aligned with patients' goals, literacy levels, or emotional needs. As healthcare increasingly adopts asynchronous digital platforms, there is a growing need for adaptive, engaging, and personalized formats that reflect individual experiences.

#### 1.1.1 Limitations of Current Approaches

Most health education relies on one-size-fits-all text with limited tailoring or visual support. Studies show that these materials often fail usability and readability standards across domains such as hearing health and cancer care [17, 7, 21]. Patients forget or misinterpret up to 80% of medical information after visits [14], and comprehension suffers further from fragmented text and communication gaps introduced by EMR use and secure messaging [20, 18, 11].

#### 1.1.2 Why Patient Goals Matter

Personal goals—such as "sleep better" or "return to daily activities"—rarely appear in standard materials, despite their central role in shared decision-making and patient-centered care [1]. Recent systems using large language models (LLMs) can now extract such goals from secure clinical messages [6], enabling targeted communication. This builds on work in tailored health messaging, health behavior apps, and modular

interventions [4, 13, 5]. In GoalViz, patient-defined goals serve both as the narrative anchor and as a lens for educational intent.

#### 1.1.3 Narrative and Visual Learning

Narrative-based learning improves comprehension, emotional resonance, and recall by embedding information in relatable storylines [10, 9]. Visual storytelling—using metaphor, animation, and sequential scenes—supports conceptual clarity, emotional framing, and memory retention [16, 24, 23]. Prior work has demonstrated the value of comics, visual metaphors, and serious games in conveying health information [15]. Games like *That Dragon, Cancer* [8] and interactive tools like *At-Risk* [12] show how emotionally grounded storytelling fosters reflection and learning. Our own research in visual narrative modeling [2, 3] provides technical grounding for generating adaptive, symbolic stories that reflect patient experience and support narrative comprehension.

#### 1.1.4 Why Now: Advances in Generative AI

Recent breakthroughs in LLMs and vision-language models (VLMs) enable automatic generation of coherent narratives and visuals from structured input. Systems such as Keyframer [22], MoGraphGPT [25], and Data2Story [19] illustrate how generative pipelines can create animated or interactive content. Yet few efforts apply these capabilities to personalized health education or integrate patient goals as a guiding input. GoalViz bridges this gap by transforming extracted goals into interactive, metaphor-rich visual narratives—combining techniques from generative storytelling, symbolic reasoning, and visual communication for personalized and emotionally meaningful learning experiences.

## 2 Goals and Objectives

This project aims to develop **GoalViz**, a generative AI system that produces *interactive narrative-based educational content* grounded in patient-defined goals. By integrating large language models (LLMs), vision-language models (VLMs), and symbolic storytelling structures, the system supports personalized, emotionally resonant, and adaptive health learning experiences. The project pursues the following objectives:

1. **Goal extraction and grounding:** Adapt an LLM-based pipeline to extract patient goals from secure clinical messages [6], serving as the basis for selecting content and shaping narrative intent.

2. **Narrative scenario generation:** Design a controllable module that maps extracted goals and medical knowledge into interactive learning narratives using symbolic event modeling and templates.

3. **Visual synthesis with metaphor alignment:** Use VLMs to generate stylized scenes from prompts, embedding metaphorical framing (e.g., "fog" for confusion) to support clarity and emotion.

4. **Evaluation and refinement:** Define automatic and expert-informed metrics to assess alignment, coherence, and clarity. If feasible, conduct an exploratory user or expert feedback study to guide iteration.

5. **Prototype and dissemination:** Build a web-based prototype and share outputs, code, and findings through peer-reviewed publications and outreach to digital health and education communities.

## 3 Methodology

We propose **GoalViz**, a generative AI system that creates interactive narrative-based health education experiences tailored to patient-defined goals. The pipeline integrates four core modules: (1) goal extraction, (2) narrative generation, (3) visual synthesis, and (4) evaluation and refinement. These components work together to produce adaptive, emotionally resonant learning scenarios grounded in both clinical knowledge

and individual patient intent. To illustrate how the system works, consider a breast cancer patient undergoing chemotherapy who writes in a secure message: *"I just want enough energy to play with my child again."* This goal is rarely reflected in traditional fatigue management materials, yet it reveals both a **personal goal** (recover energy) and a **learning need** (understand how to manage treatment-related fatigue). GoalViz transforms this into an interactive visual journey where the patient takes the role of a character on a symbolic path toward recovery. Scenes and dialogue adapt based on simple choices, helping patients build insight and motivation through emotionally grounded education.

### 3.1 Goal Extraction and Mapping

We extend an LLM-based pipeline developed by Fodeh et al. [6] to extract structured health goals from secure messages. Goals like "reduce fatigue" or "sleep better" are normalized into templates and mapped to clinical knowledge areas (e.g., fatigue management, lifestyle support). This mapping anchors the system's subsequent storytelling and visual content generation.

### 3.2 Narrative Scenario Generation

Narrative scenarios contextualize medical knowledge within short, adaptive stories aligned with patient goals. We implement two strategies:

- **Template-based generation:** We use symbolic narrative arcs (e.g., challenge–attempt–resolution) to scaffold stories. Slots are filled with goal-relevant challenges and solutions, ensuring control over tone, clarity, and domain alignment.
- **LLM-based generation with constraints:** We apply prompt-based generation using large language models, augmented by structural templates or filters to enforce progression and factual accuracy.

These scenarios may contain dialogue, branching paths, and reflective moments that mirror real-life decisions, reinforcing engagement and comprehension.

### 3.3 Visual Synthesis and Metaphor Alignment

Narrative scenes are rendered using vision-language models (VLMs) guided by prompt templates incorporating metaphor (e.g., fog as fatigue, bridges as coping tools) and narrative roles (e.g., guide, patient). Outputs include visual novel–style panels, with decision points enabling adaptive progression. Visual metaphors are grounded in medical context and designed to preserve emotional sensitivity and conceptual clarity.

### 3.4 Evaluation and Refinement

System outputs will be evaluated across four dimensions:

- **Goal alignment:** Do scenarios reflect the patient's intent and values?
- **Educational value:** Is the clinical content accurate, accessible, and relevant?
- **Visual-narrative coherence:** Are visuals and metaphors aligned with the story arc and goal?
- **Engagement and usability validation:** (Exploratory) Assess how users perceive the system's clarity, motivational impact, and emotional resonance through structured feedback and observation.

Evaluation will combine automatic metrics (e.g., semantic similarity scores), narrative structure checks, and structured expert review. A small-scale feedback or usability study will be conducted if time and resources permit.

### 3.5 Prototype and Dissemination

We will implement a functional web-based prototype that integrates goal extraction, narrative scaffolding, and visual rendering. The system will support internal testing and future expansion. Selected modules, sample outputs, and evaluation protocols will be shared openly. Results will be submitted to top venues in AI, human-computer interaction, and health communication.

# 4 Contribution to the Yale AI Initiative

This project advances the Yale AI Initiative's mission by developing **GoalViz**, a responsible, interdisciplinary generative AI system for personalized health education. By transforming patient-defined goals into interactive, narrative-based visual content, it exemplifies how human-centered AI can improve equity and engagement in clinical communication. **GoalViz** integrates large language models (LLMs), vision-language models (VLMs), and symbolic storytelling to produce emotionally resonant and conceptually clear learning experiences. Its multimodal pipeline advances controllable generative AI by aligning goal-conditioned narratives with metaphor-enhanced visual synthesis. The project contributes to the Initiative's core areas:

- **Innovation and Impact:** Introduces a novel AI-driven pipeline that translates patient goals into adaptive visual narratives. Combines symbolic and generative methods for personalized learning, advancing research in goal-aware generation and interactive visual education.
- **Human-Centered and Value-Aligned AI:** Grounds educational content in patient goals, ensuring outputs reflect individual values and health needs. This goal-driven approach fosters empathy, supports shared decisions, and advances communication equity for underserved and low-literacy groups.
- **Interdisciplinary Collaboration:** Brings together AI researchers, clinicians, and digital health experts, demonstrating the Initiative's vision for collaborative, translational impact.
- **Responsible and Transparent AI:** Integrates explainable symbolic structures with hybrid evaluation (automatic + expert-informed), ensuring clarity, safety, and accountability in outputs.
- **Scalable Infrastructure and Institutional Impact:** Delivers reusable assets—datasets, generation modules, and evaluation tools—supporting future work in AI for education, communication, and healthcare.

In summary, **GoalViz** exemplifies methodological innovation and social relevance, applying generative AI to a critical healthcare challenge and advancing Yale's vision for responsible, transformative AI.

# References


[1] Michael J Barry and Susan Edgman-Levitan. "Shared decision making—the pinnacle of patient-centered care". In: *New England Journal of Medicine* 366.9 (2012), pp. 780–781.

[2] Yi-Chun Chen and Arnav Jhala. "A computational model of comprehension in manga style visual narratives". In: *Proceedings of the Annual Meeting of the Cognitive Science Society*. Vol. 43. 2021.

[3] Yi-Chun Chen and Arnav Jhala. "Collaborative Comic Generation: Integrating Visual Narrative Theories with AI Models for Enhanced Creativity". In: *arXiv preprint arXiv:2409.17263* (2024).

[4] Wendy F Cohn et al. "Tailored educational approaches for consumer health: A model to address health promotion in an era of personalized medicine". In: *American Journal of Health Promotion* 32.1 (2018), pp. 188–197.

[5] Selena Davis, Syed Sibte Raza Abidi, and Sam Stewart. "A compositional personalization approach for designing personalized patient educational interventions for cardiovascular risk management". In: *MEDINFO 2010*. IOS Press, 2010, pp. 629–633.

[6] Samah Fodeh et al. *Using Large Language Models to Capture Patient Preferences and Goals in the Patient Portal*. In preparation. 2025.

[7] Daniela B Friedman and Laurie Hoffman-Goetz. "A systematic review of readability and comprehension instruments used for print and web-based cancer information". In: *Health Education & Behavior* 33.3 (2006), pp. 352–373.

[8] Numinous Games. *That Dragon, Cancer*. Narrative game exploring a family's experience with childhood cancer. 2016. URL: https://www.thatdragoncancer.com/.

[9] Jennifer B Gray. "The power of storytelling: Using narrative in the healthcare context". In: *Journal of Communication in Healthcare* 2.3 (2009), pp. 258–273.

[10] Melanie C Green. "Narratives and cancer communication". In: *Journal of communication* 56 (2006), S163–S183.

[11] Jennifer Fong Ha and Nancy Longnecker. "Doctor-patient communication: a review". In: *Ochsner Journal* 10.1 (2010), pp. 38–43.

[12] Kognito Interactive. *At-Risk*. Interactive simulation used for mental health intervention training. 2010. URL: https://kognito.com/products/at-risk.

[13] Atreyi Kankanhalli et al. "Understanding personalization for health behavior change applications: A review and future directions". In: *AIS Transactions on Human-Computer Interaction* 13.3 (2021), pp. 316–349.

[14] Roy PC Kessels. "Patients' memory for medical information". In: *Journal of the royal society of medicine* 96.5 (2003), pp. 219–222.

[15] Melinda Krakow. "Graphic narratives and cancer prevention: A case study of an American Cancer Society comic book". In: *Health Communication* 32.5 (2017), pp. 525–528.

[16] Mark J Landau, Jamie Arndt, and Linda D Cameron. "Do metaphors in health messages work? Exploring emotional and cognitive factors". In: *Journal of Experimental Social Psychology* 74 (2018), pp. 135–149.

[17] Vinaya Manchaiah et al. "Quality, readability, and suitability of hearing health-related materials: A descriptive review". In: *American journal of audiology* 29.3 (2020), pp. 513–527.

[18] Aviv Shachak and Shmuel Reis. "The impact of electronic medical records on patient–doctor communication during consultation: a narrative literature review". In: *Journal of evaluation in clinical practice* 15.4 (2009), pp. 641–649.

[19] Leixian Shen et al. "From data to story: Towards automatic animated data video creation with llm-based multi-agent systems". In: *2024 IEEE VIS Workshop on Data Storytelling in an Era of Generative AI (GEN4DS)*. IEEE. 2024, pp. 20–27.

[20] Catherine Arnott Smith et al. "Beyond readability: investigating coherence of clinical text for consumers". In: *Journal of medical Internet research* 13.4 (2011), e1842.

[21] Chenlu Tian et al. "Readability, suitability, and health content assessment of web-based patient education materials on colorectal cancer screening". In: *Gastrointestinal endoscopy* 80.2 (2014), pp. 284–290.

[22] Tiffany Tseng, Ruijia Cheng, and Jeffrey Nichols. "Keyframer: Empowering animation design using large language models". In: *arXiv preprint arXiv:2402.06071* (2024).

[23] Barbara Tversky, Julie Bauer Morrison, and Mireille Betrancourt. "Animation: can it facilitate?" In: *International journal of human-computer studies* 57.4 (2002), pp. 247–262.

[24] Agata Wezyk. "Understanding stress and health through the use of visual metaphor." PhD thesis. Bournemouth University, 2021.

[25] Hui Ye et al. "MoGraphGPT: Creating Interactive Scenes Using Modular LLM and Graphical Control". In: *arXiv preprint arXiv:2502.04983* (2025).

## Proposal Abstract – 150–250 words direct entry, now 224 words

Cancer patients often express deeply personal goals, such as managing fatigue, returning to work, or regaining time with loved ones, through secure messages and clinical conversations. However, most educational content in healthcare remains static and one-size-fits-all, offering limited support for these individualized needs. This project proposes GoalViz, a human-AI co-creative system that transforms patient-defined goals into personalized, interactive visual narratives for health education.

Using recent advances in large language models (LLM) and vision language models (VLM), GoalViz generates metaphor-rich story experiences grounded in clinical knowledge and expressed through visual-novel–style dialogue and symbolic imagery. For example, a breast cancer patient reporting treatment-related fatigue may receive an animated roadmap scenario, where an avatar navigates fatigue management strategies, shaped by her stated goal and emotional context.

The system aims at patients who manage complex or emotionally challenging conditions and is designed to integrate into clinical workflows or patient education portals. Key evaluation dimensions include (1) alignment of the goal and content, (2) narrative coherence, and (3) visual-semantic clarity. These will be assessed through semantic similarity metrics and expert or user feedback.

By combining goal-conditioned AI generation, symbolic visual storytelling, and adaptive interaction, GoalViz contributes both foundational methods for multimodal narrative AI and a scalable tool for personalized healthcare education. This work addresses the priorities of the Yale AI Initiative in responsible, human-centered, and interdisciplinary AI research.

## Team Narrative – 250-word direct entry, now 244 words

This project brings together interdisciplinary expertise in artificial intelligence, medical oncology and cancer care, biomedical informatics, and patient-centered communication to develop **GoalViz**, a generative AI system for personalized, narrative-based health education.

**Dr. Samah Jarad-Fodeh - PI**, Associate Professor of Emergency Medicine at Yale University, serves as Principal Investigator. With extensive experience in text analytics, clinical informatics, secure messaging communication, and digital health, she will lead and supervise the design and development of the GoalViz system with all its components. She will supervise various project oversight, ensure ethical integration of patient portal data, and guide alignment with healthcare priorities.She will lead dissemination of project findings.

**Dr. Sarah Schellhorn - Co-I**, Associate Professor of Medical Oncology, contributes clinical expertise in cancer patient communication, cancer care and patient-reported outcomes. She will advise on scenario relevance, validate patient language related to goals and preferences, and help ensure educational content reflects the lived experiences of oncology patients.

**Dr. Yi-Chun Chen**, Postdoctoral Associate in Computer Science, is the project's technical lead. Dr. Chen brings research expertise in human-AI collaboration, generative narrative systems, and visual storytelling. They will participate in the system design and will lead the development of the generative pipeline, including goal-conditioned narrative generation, metaphor-driven visual synthesis, adaptive interaction design, and prototype implementation. Dr. Chen will also coordinate evaluation and lead dissemination.

**Dr. Linhai Ma**, Postdoctoral Associate in Biomedical AI, contributes expertise in deep learning, NLP, and multimodal evaluation. He will assist with technical development, focusing on scenario refinement, model integration, and validation of narrative and visual outputs. Together, the team combines complementary strengths across computational, clinical, and design domains to advance responsible AI. Their collaboration supports the Yale AI Initiative's mission through scalable, patient-centered tools that promote communication equity in healthcare.

## Budget and Justification

This proposal requests a total of $100,000 to support the development and evaluation of a generative AI system for personalized narrative-based health education. The budget spans an 18-month project period and complies with Yale AI Seed Grant guidelines.

### 1. Personnel – $89,650

- **Postdoctoral Associate Salary (Dr. Yi-Chun Chen) – $68,000:** Full 12-month salary support at 100% effort. Dr. Chen will lead the technical development of the system, including goal-conditioned narrative generation, symbolic event structuring, visual synthesis prompts, and user-facing prototype design.
- **Postdoctoral Support (Dr. LinHai Ma) – $21,650:** Partial salary support for a second postdoctoral associate. This covers approximately 4 months at 100% effort or 8 months at 50%. The second postdoc will support the development of the evaluation pipeline , assist in visual prototyping using generative models, and contribute to technical documentation and system testing.

### 2. Cloud Computing – $4,000

- **Cloud Services – $4,000:** Usage credits for AWS, Azure, or equivalent platforms to support model training, visual rendering, data storage, and deployment of generative modules (e.g., diffusion models, animation synthesis).

### 3. Dissemination and Outreach – $6,350

- **Open-Access Publication Fees – $2,500**: For publishing in peer-reviewed AI and HCI journals such as ACM TiiS, ACM TOMM, or IEEE TVCG.
- **Conference Travel – $3,500**: Travel and registration for dissemination at top-tier venues such as ACM Multimedia (ACMMM), ACM CHI, or AAAI workshops.
- **Miscellaneous Research Supplies – $350**: Small technical accessories or prototyping equipment not covered under general office supply budgets.

**Total Requested Budget: $100,000**

## Timeline and Milestones

**Duration: 18 months (starting July 1, 2025)**

- **Months 1–3: Project Setup and Goal Extraction Integration** Finalize project plan and system architecture. Integrate and adapt the LLM-based goal extraction pipeline using de-identified patient messages. Conduct a literature review on narrative framing in health education and define mappings from extracted goals to educational intents.
- **Months 4–6: Narrative Content Generation** Design the symbolic narrative structuring module. Develop reusable event-based templates and generate short narrative scenarios aligned with extracted goals and medical content. Begin testing LLM-based generation with constraints for coherence and control.
- **Months 7–9: Visual Metaphor and Scene Design** Develop a metaphor-driven visual element library (e.g., icons, scenes, animations). Design and tune VLM prompt templates to generate stylized visuals that match narrative tone and clarify abstract health concepts.
- **Months 10–12: System Integration and Iterative Testing** Integrate goal extraction, narrative generation, and visual synthesis into a working prototype. Conduct internal testing and refinement. Incorporate feedback from domain experts to assess alignment, clarity, and emotional resonance.
- **Months 13–15: Exploratory Evaluation and Feedback Collection** If time and resources permit, conduct an exploratory user or expert study to gather preliminary feedback on comprehension, engagement, and alignment with patient goals. Alternatively, structured expert review may be used to assess clarity and usefulness. Insights from this phase will guide system refinement and inform future directions.
- **Months 16–18: Finalization and Dissemination** Finalize the prototype, annotated scenarios, and visual examples. Prepare academic publications and outreach materials. Submit findings to venues such as ACM CHI, ACM Multimedia, AAAI workshops, or AMIA. Prepare datasets and source code for open-access dissemination where feasible.