Supporting Marginalized Learners with GenAI (Extended Abstract)

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Abstract

Access to quality education remains deeply unequal, particularly for learners in low-resource and socio-politically unstable contexts. Although Generative AI (GenAI) interventions have the potential to provide educational support, they are rarely designed and developed with marginalized communities, especially within challenging socio-political environments. My research addresses this gap by exploring, designing, and developing responsive GenAI interventions specifically tailored to support women in Afghanistan pursuing programming education despite substantial barriers. Through exploratory research, participatory design, and iterative evaluation, I aim to uncover how GenAI can effectively enhance learning outcomes and aspirations within this underserved community. Ultimately, my work contributes to more equitable AI development practices and actively supports marginalized communities by enabling access to meaningful education and the development of employable skills.

Background and Motivation

Access to education, especially in technical fields like programming, remains a profound challenge for marginalized communities, particularly in regions affected by socio-political instability and gender-based restrictions. The fall of the Republic of Afghanistan in 2021 led to severe rollbacks in women's rights, including an outright ban on girls' secondary and higher education. For women in Afghanistan, whose educational and career aspirations have been severely affected (Qaderi et al. 2023; Abbasi, Arnpriester, and Yavan 2024), there is an urgent need for accessible alternative learning interventions to support their pursuit of economic independence and intellectual growth. While online learning and open educational resources have become more available, these solutions are far from sufficient. Learners face numerous barriers with inconsistent internet access, English-language interfaces, the absence of live support, and deep socio-cultural constraints on autonomy and participation.

Generative AI (GenAI), particularly large language models (LLMs) like ChatGPT (OpenAI 2022), presents an emerging opportunity to bridge some of these gaps, offering personalized learning and supporting students (Denny et al. 2024). In learning programming, these models can provide instant, personalized assistance with coding tasks, explanations of technical concepts, and even emotional encouragement (Phung et al. 2024; Dong 2023). Yet, they are rarely designed and developed with marginalized communities within a socio-politically challenging context. The need for fluent English literacy, uninterrupted access to the internet, and a cultural context far removed from the lives of learners in such a context. My research investigates how we can responsibly adapt and apply GenAI intervention to support not only the technical learning but also the aspirations of learners navigating socio-political instability.

In a prior work (Behmanush et al. 2025b), we conducted mixed-methods research with women in Afghanistan enrolled in online programming courses, and we found that learners used GenAI tools in resourceful ways to debug code, clarify difficult topics, and gain motivation in their learning. However, these benefits were tempered by practical limitations such as access barriers, lack of localized content, and limited support for local languages.

These findings form the foundation for further investigation on co-designing and deploying a GenAI intervention that centers the experiences and constraints of marginalized learners. By foregrounding learners' voices, cultural context, and infrastructural challenges, I aim to design and develop GenAI interventions that are not only technically effective but also empowering and socially grounded. This work contributes to reimagining GenAI for education, not as a generic productivity tool, but as a partner in resilience, aspiration, and equitable skill-building.

Methodology

To understand how GenAI can effectively support the education of marginalized learners, particularly in learning programming, my research employs exploratory, design-based approaches that integrate both qualitative and quantitative methods. In earlier studies (Behmanush et al. 2025b,a), we used surveys and interviews to understand how women enrolled in online programming courses engaged with large language models like ChatGPT. These methods revealed both technical usage patterns, such as using LLMs for debugging or code explanation, and deeper impacts on learner confidence, goal-setting, and motivational resilience. These insights directly informed our current design study.

In the current phase of our work, we closely work with

women in Afghanistan by conducting participatory design sessions to identify features that would make a GenAI useful and usable in their context. These sessions involve storyboarding (Ghafar, Raheem, and Mahmood 2023) and iterative feedback, allowing participants to explain how a GenAI intervention can contextually and culturally support them. This collaborative process ensures the design is rooted in cultural and infrastructural realities, such as challenging internet access, language preferences, and learning styles.

The next phase will involve deploying a working prototype in real-world learning environments. I aim to measure learner engagement, learning outcomes, and aspiration-related change using the adapted Hope Scale (Behmanush et al. 2025a).

Future Directions

Upon completion of the current design study, I will be developing a working prototype of a GenAI intervention informed by the participatory design phase. This prototype will be tested in controlled sessions with learners to observe real-time interactions and identify pain points in usability, clarity, and responsiveness. Chat histories will also be analyzed, and participants will be interviewed to evaluate whether the intervention simulates authentic learning interactions while remaining sensitive to infrastructure constraints such as internet connectivity, language barriers, and other limitations.

Following the early evaluation, I will deploy the GenAI intervention in actual educational settings. I plan to conduct a longitudinal evaluation of its impact on learning outcomes (via pre- and post-assessments) and changes in aspirations and agency (measured using the adapted Hope Scale). This phase will generate empirical evidence on the long-term value of GenAI-assisted learning in low-resource settings and guide future adaptations to make AI tools more inclusive and supportive of marginalized communities.

To address the risk of LLM hallucinations, the prototype will integrate retrieval-augmented generation (RAG) using external educational resources to improve factual reliability. Recent work (Wu et al. 2025) has shown that extending RAG with mechanisms for structured knowledge integration and confidence-based filtering can effectively mitigate hallucinations across diverse sources. Building on this insight, the prototype will ensure retrieved content is both contextually relevant and trustworthy. During controlled sessions, participants' interactions will be monitored, and outputs will be cross-checked for accuracy. Lightweight verification mechanisms (such as unit tests for code) will also be explored to minimize harmful or misleading guidance.

While my current focus is on marginalized communities amid socio-political instability, ultimately, I aim to generalize this approach to broader contexts such as refugee education, contributing to a more inclusive vision of AI for education.

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