An Exploration of Augmented Reality to Increase the Visibility of Women in Research

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Figure 1: Screenshots of *EmpowARher*, our prototype exploring the use of Augmented Reality to increase the visibility of women in research during a campus tour. It features a) a Researcher List, b) a Profile, c) a Timeline of achievements, and d) a Globe showing academic stations.

Abstract

Limited visibility of women in research deprives aspiring researchers of role models, reinforces stereotypes, and discourages academic persistence. Augmented Reality (AR), while still underexplored, offers an opportunity to integrate it into campus tours to increase the visibility of women researchers at universities. We contribute in three ways to the exploration of how AR can increase the visibility of women in research. First, we conducted a design workshop with Human-Computer Interaction (HCI) researchers (n=8; 7 women) to explore what information to present and how. Then we built an AR prototype that displays real data from women researchers (n=9) for use at university events or on campus tours. Finally, we discuss challenges and opportunities for future research and projects aimed at improving the visibility of women in research through AR.

CCS Concepts

• **Human-centered computing → Mixed / augmented reality**; *HCI design and evaluation methods.*

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Keywords

Women in Research, Visibility of Women, Role Models, Gender Stereotypes, Augmented Reality

1 Introduction

Women researchers Ada Lovelace, Rosalind Franklin, and Eunice Foote are only a few examples of a long list of women whose work shaped our present, yet they remain less well known to the public than their male counterparts [6, 34]. The underrepresentation of women across various research fields has been highlighted by numerous sources [13, 17, 40, 41, 43, 58, 61]. To this day, the lack of visibility of women researchers and leaders remains a persistent issue, one that not only affects how these women and their competence are perceived but also shapes future generations. Without women as role models, fewer women are likely to enter research, further limiting their perspective in the design, testing, and evaluation of technologies (see also Feminist Human-Computer Interaction (HCI) [4]). Thus, limited visibility of women in research increases the risk that tools and systems will be less inclusive due to a predominantly male perspective.

This underrepresentation cannot be attributed to a single cause but instead emerges from a constellation of structural and cultural barriers, including socio-cultural norms [3, 24, 30, 47], social exclusion from science [27], lack of attribution [53], lack of visible relatable role models [38], and academic work environments [9, 21, 29, 31]. These barriers contribute to the “leaky pipeline” [39], which describes how women disproportionately exit academic careers.

Many efforts have been made to increase the visibility of historical and contemporary women in research, providing role models for aspiring researchers and encouraging women to pursue academic careers. A key setting for these efforts is the university campus, where Augmented Reality (AR) provides spatial situatedness, anchoring narratives directly to the physical locations where women researchers work, something not possible with static media such as posters or flyers. Bringing these narratives to life involves a trade-off between immersion and cost: Head-Mounted Displays (HMDs) offer high immersion, while Handheld Devices (HHDs) provide a more pragmatic, comparably scalable option. While both approaches entail addressing development complexity, maintenance demands, and initial usability barriers, these hurdles are manageable through expert engineering and onboarding.

Motivated by these opportunities, we explore the use of AR during a campus tour to increase women's visibility in research, gathering initial insights into its potential and challenges for future work. To this end, we contribute: (1) the results of a design workshop on what information about women in research to visualize and how, (2) *EmpowARher*, an AR prototype exemplifying design possibilities for representing women in research (see Figure 1a) in the light of their academic and personal lives (see Figure 1b) through an immersive AR experience deploying a walkable timeline (Figure 1c) and an interactive globe showing the researcher's academic stations (Figure 1d), and (3) challenges and opportunities for future use of AR to amplify the visibility of women in research.

2 Related Work

Many efforts, both within and beyond research, have been dedicated to addressing the invisibility of women, including AR-based initiatives. We build on these and on research in adjacent domains.

Traditional efforts include podcasts [35, 36], mentoring programs [8], active learning [46], art [50], and possibilities for journals to improve equity, diversity, and inclusion (EDI) [15]. Complementing these are solutions, such as documentaries and video-based interventions [32, 45, 47, 48], online databases [5, 19, 26], and serious games [56]. Pietri et al. [47] developed a video-based intervention to increase gender bias literacy through narrative stories and expert interviews. Another initiative is *The Lost Women of Science* [37], a nonprofit educational organization with a mission to uncover the untold stories of women scientists and to inspire young women to pursue careers in Science, Technology, Engineering, and Math (STEM) through different media platforms, including podcasts, books, and theater. Similarly, *Women in Data Science* (WiDS) [25] is an initiative that aims to empower the next generation of data science and Artificial Intelligence (AI) leaders through annual conferences, workshops, a community platform, and programs like *NextGen* that encourage young women to pursue careers in STEM by showcasing successful women in related roles. Initiatives that use AR include showing virtual statues of historic female figures [7], allowing girls to virtually meet female STEM heroes [51], and providing STEM lessons and inspiring stories for middle school girls [12].

In education, AR has been shown to improve motivation and knowledge acquisition by transforming abstract concepts into interactive 3D experiences [20, 42, 49, 55, 60], highlighting its promise as an engaging medium for sparking audiences' interest in learning about researchers' narratives. Cultural heritage sites and museums also use AR to provide personalized and accessible learning, while also enabling the reconstruction of damaged historical sites to preserve heritage and allow visitors to explore them in their original state [10, 44, 52, 62–64]. These affordances, which allow each visitor to absorb information at their own pace, also motivate our choice of AR. In the aforementioned domains, researchers have used AR to address challenges adjacent to ours, with shared goals of delivering information in an immersive, situated manner.

Further, AR has been used to engage art-oriented girls with technology and science [14], as a feminist art intervention [16], and to satirically engage with gender stereotypes through AR filters [59]. Researchers have also explored ways to enhance campus visits by offering immersive, self-guided AR experiences that engage young visitors more effectively while reducing the need for staff involvement [1, 2, 11, 18, 28]. More closely related to our work are a discussion of AR tools and experiences for social change [54], an exploration of gender and power dynamics in STEM [22], and an investigation of supporting diversity in STEM through AR [23]. More specifically, Silva et al. [54] sought to unravel the opportunities and challenges of using AR for activism. They conducted interviews with 20 people who participated in AR projects for social causes and uncovered opportunities and challenges, including improving AR discoverability and maintaining AR experiences. In the context of STEM, Holopainen et al. [22] investigated how AR can combat academic stereotypes. To this end, they conducted a co-design workshop with six academics, presenting them with an AR prototype illustrating a narrative on gender-based discrimination and asking them to ideate possible endings to the story. Furthermore, Holopainen et al. [23] used AR to explore gender-based discrimination through feminist HCI [4] and research-through-design [65] methods. Through a co-design workshop featuring paper-based AR prototypes, they derived design implications for addressing diversity issues, such as leveraging AR to make conflict-resolution training more realistic.

These related works demonstrate the broad interest in, and benefits of, using AR to engage users with content and drive social change. Similarly, we want to explore how AR can drive social change, with a focus on women in research and on integrating AR into a campus tour to foster visibility. To this end, we provide initial insights into the possibilities and challenges of using AR through a design workshop and a prototype.

3 Design Workshop

As a first step toward using AR to increase women's visibility in research, we conducted a 2-hour participatory design workshop. Together with eight HCI researchers (7 women, 1 man; 7 PhD candidates, 1 Postdoc), we brainstormed which data on women in research to present in an AR prototype during a campus tour and explored how to design and communicate it.

The workshop began with a 45-minute ideation session, during which participants, in small groups, brainstormed ideas for an AR-based university campus tour to increase the visibility of women in research. Then, all participants discussed their ideas together. In a second 45-minute ideation session, the participant groups were mixed up and tasked with exploring and discussing which aspects of a researcher's personal and academic life they found important, and how to present them during an AR campus tour.

During the workshop, we photographed all drawn and written ideas for subsequent digital organization and annotation. The first authors together clustered all ideas using affinity diagramming, following a bottom-up approach to group conceptually related ideas. Then all authors iteratively discussed and refined the clusters.

The affinity diagramming process resulted in 51 final items divided into five clusters (see Figure 2), reflecting different perspectives on the potential of AR to increase the visibility of women in research. Below, we describe these clusters and their sub-clusters, followed by a brief discussion of our workshop results.

The cluster **Goals** (9/51) includes both *Short-term* (7) objectives, like covering "various domains", and *Long-term* (2) systemic challenges such as "unraveling bias". **Usage setting** (5/51) is divided into the targeted *Audience* (2), like "young women", and *Events* (3) that could benefit from an AR solution, such as a public "Science Day", at which pupils visit universities. **Information** (12/51) groups items about what *Personal* (2) and *Professional* (8) aspects to present, such as a woman researcher's "name", "number of kids", "academic age", "publications", "awards", and "career path", as well as *Environment*-related (2) information like Points of Interest (POIs) and building names. **Representation** (21/51) is the largest category, encompassing concepts for presenting and interacting with the information. It includes the sub-categories *Visualization* (3), like "word clouds", *Highlighting* (2) content in 3D space, showing data in a *Gallery* (3), *Storytelling* (2) techniques, *Videos or Holograms* (4) of researchers, *Navigation* (5) of the environment, and *Gamification* (2). Finally, we split proposed **Features** (4/51) into *Internal* (3), like "filters", and *External* (1) (i. e., a website for "remote access").

Overall, our workshop participants showed both interest and creativity in using AR to increase the visibility of women in research and contributed a wide variety of ideas. While the long-term goals (e. g., "more female leaders") are not attainable through a single intervention, they underscore the importance of the topic. They should be kept in mind while pursuing short-term goals, such as "females receive information about research". The multitude of *Usage Settings* mentioned demonstrates AR's flexibility and should encourage developers and researchers to consider diverse audiences and events. Although several promising ideas fall under *Representation*, they require careful consideration regarding social acceptance and audience suitability. For example, ideas involving videos of researchers raise questions of willingness and availability. Another example is gamification, which may appeal to certain audiences but is not necessarily intuitive or engaging for everyone.

Looking forward, we believe our results could serve as a starting point for developers, artists, and researchers. Future workshops should include participants from diverse personal and professional backgrounds to broaden the range of suggestions and delve deeper into specific goals, usage settings, and representations. Further, our workshop participants covered researchers, but not the target audience of interested young women and girls. As these groups are likely to be interested in different information (see also Section 5), a valuable next step would be co-design workshops with members of the target audience.

4 EmpowARher: An AR Prototype

To create a first AR prototype (Figure 1) and keep the experience manageable, we selected a subset of the ideas gathered during the design workshop to implement using Unity[1]. With the *Long-term* **Goals** in mind, we aimed for a *Short-term* solution and created an "AR application" that could be used during a "Campus tour" or "Science Day" and focused on *Visualizations* for the **Representation** of the information. To make *EmpowARher* as immersive as possible, we opted for a stationary HMD-based approach rather than an HHD-based one. We aimed to present a broad set of information and to leverage interactivity and the ability to display data in three dimensions while keeping interactions simple and navigation clear.

EmpowARher consists of four components that are distributed around the user, but can be moved around flexibly. The entry point is a Researcher List (Figure 1a) that offers a concise overview of all featured researchers, including an image, academic title, name, academic position, keywords, German Research Foundation (DFG) classification of their research, and the logo of their current institute.

The Profile (Figure 1b) further presents their number of children, academic age, career path, publications, awards, grants, biological age, date of birth, relationship status, care duties, and a quote of their choice. To combine the ideas of *Storytelling* and *Videos or Holograms*, we added the interviews we recorded, split into separate questions. The profile spans multiple pages, and we use the feedforward [33] concept to signal their presence by making them semi-transparent. Additional screenshots of the profile are available in the supplemental material.

To leverage the interactivity and 3D capabilities of AR, we implemented a Timeline (Figure 1c) and a Globe[2] (Figure 1d) that let the user experience the researcher's career path interactively. The Globe illustrates the stages of a researcher's career through arcs connecting the countries where they have worked. Users can explore the Globe by walking around it or by moving and rotating it. The Timeline extends into 3D space and displays the researcher's academic achievements (publications, awards, grants) as text and 3D icons in chronological order, allowing the user to explore them as if walking in the researcher's footsteps.

To obtain real-world data on women in research, we collected information from 9 women researchers in our network via an online questionnaire and a subsequent in-person interview with one of them. Seven of the women work in Engineering Sciences, one in Natural Sciences, and one in Humanities and Social Sciences. The questions covered biographical, demographic, and professional data, included options to upload an academic Curriculum Vitae (CV) and a portrait photo, and concluded with an open-ended feedback form. The recorded interview served to humanize the researchers' stories, offering qualitative insights into their career motivations, the role models who influenced them, the challenges they faced, and their advice for future generations.

Finally, we conducted a pilot study with 25 students from our university (Age range: 18-24 (13), 25-34 (12); Gender: 13 women, 11 men, 1 did not disclose). This initial investigation into the usability (SUS: 81.4/100) and perceived workload (NASA-TLX: 15.4/100)

[1] https://unity.com
[2] Implementation based on https://github.com/KadekSatriadi/Viz-Globe/tree/master

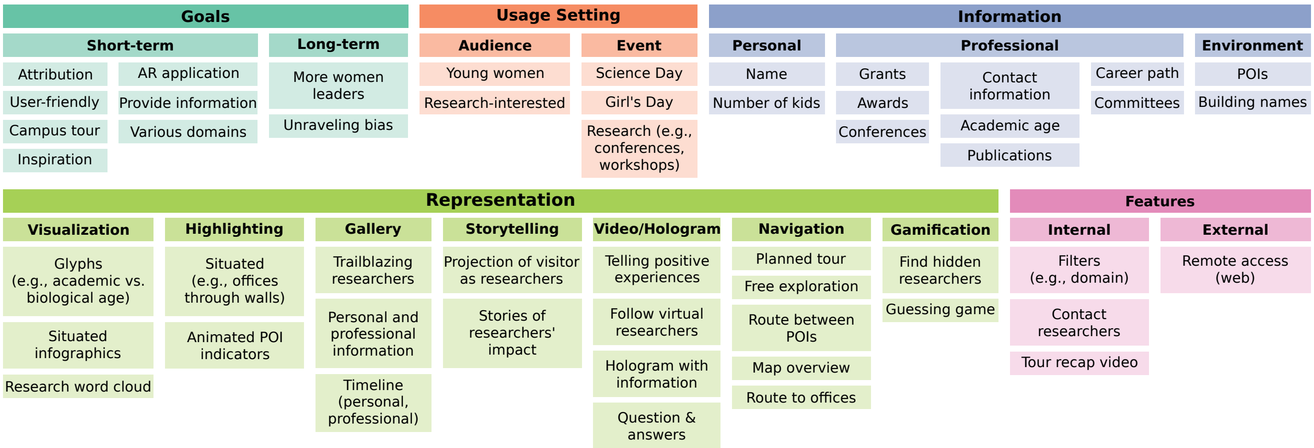

Figure 2: Affinity diagram of the ideas collected in the design workshop on increasing the visibility of women in research using AR for a campus tour, covering *Goals*, *Usage setting*, which *Information* to show, their *Representation*, and supporting *Features*.

of *EmpowARher* indicates high usability and low workload. Further details can be found in the supplementary material.[3]

5 Challenges and Opportunities

During our exploration of using AR to increase women's visibility in research, we encountered several challenges and opportunities, which we discuss below to help guide future research.

Gathering input from women in research proved challenging for two reasons. Evidently, the underlying problem is the limited pool of potential participants who identify as women. Second, women in research, in our own experience and through conversations with the women we spoke to in the context of this work, are overburdened with responsibilities beyond research and teaching, such as committee service, domestic duties, and childcare. Based on our experience, we suggest repeatedly piloting surveys and studies to optimize completion time and reduce unclear or vague questions. Further, offer shortcuts, such as uploading a CV, if possible; clearly state the estimated time in the invitation; and, ideally, invite potential participants personally and briefly describe your goals and approach. → **Take into account, understand, and respect the workload of your potential participants when designing studies. This applies to all studies, but particular care may be needed when working with women in research.**

The workshop revealed that the participants (primarily women in research (7F, 1M)) want to highlight their awards, publications, or most-cited work. However, future generations of researchers and current undergraduate students might not be interested in the same data. We can report, based on anecdotal evidence from teaching undergraduates and presenting our work to pupils on science days, that our target audiences are more interested in work-life balance, typical research tasks, and what a day in a researcher's life looks like. → **Investigate the overlap between what women in research want to share and what the target audience is interested in. Ideally, integrate the target audience into the design process through co-design workshops.**

While AR offers immersion and engagement, developers must balance innovation against varying user literacy and physical comfort. For example, we were able to informally show *EmpowARher* to pupils and their parents during a science day, which highlighted some usability issues, despite our efforts to avoid overly complex components. Adding to this are the physical side effects, such as cybersickness, which, ironically, affect women more than men [57]. Here, handheld AR could offer a trade-off between immersion and ease of use, reduced obtrusiveness, and a lower barrier to entry. To accommodate as many people as possible, AR-based efforts should be accompanied by other media such as posters, websites, and videos. → **Consider varying technological literacy and experience when using AR technologies. Balance novelty and usability, and offer material through a diverse set of media.**

Measuring the long-term effectiveness of an AR experience intended to address a persistent social issue is inherently challenging. Such social change does not unfold overnight and is often only observable through cohort studies, which can track large-scale, long-term changes. → **Conduct long-term studies on the effects of AR to increase the visibility of women in research.**

Finally, we want to acknowledge that, while this paper focused on the visibility of women in research, we believe its ideas could also be applied to other underrepresented groups, such as people with disabilities, to various research fields, and beyond research.

6 Conclusion

For every Lovelace, Foote, and Franklin, whose stories and contributions survived throughout history, there remain countless other women in research who are largely unknown to the public. This lack of visibility for both historical and contemporary women in research deprives them of the recognition they deserve and future generations of role models beyond stereotypical images of scientists, risking the loss of perspective and talent. Although AR has been used in various domains, its potential to address the underrepresentation of women in research remains underexplored. To help close this gap, this paper explores the use of AR through a design

[3]https://osf.io/3qn24

workshop and an AR prototype called *EmpowARher*. Looking ahead, we identify several challenges and opportunities that we hope will inspire similar future interventions and advance progress toward addressing this historically persistent issue.

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