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To "talk softly or to not talk at all," That is the Question: Using Participatory Tools to Engage Women in a Biomedical Informatics Department

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ABSTRACT
Biomedical Informatics (BMI) is an interdisciplinary field that involves aspects of both biomedical engineering and healthcare informatics, each of which are also multidisciplinary. BMI is an amalgam of information technology and informatics, computer science and biomedical sciences, and healthcare and medicine. As such, there is a dearth of research on the under/representation of women in BMI. Although there is a lack of research on women in BMI, the literature surrounding women in similar and adjacent fields demonstrates a stark underrepresentation, as well as poor experiences in these male-dominated fields. While the experiences of women within related fields points to similar experiences in BMI, more research must be carried out to determine the specific barriers and hurdles that women in BMI face. The current project employs Group-Level Assessment (a participatory methodology) with women in a BMI department in order to better understand their experiences, as well as create a salient action plan towards improving those experiences. Isolation, (lack of) inclusivity, and inspiration were three key themes identified through the GLA data. The GLA participants also developed an action plan as a result of the issues that surfaced. Several of the proposed action steps were implemented within six months of the group meeting.

KEYWORDS

Women in STEM, Biomedical Informatics, isolation, inclusivity, inspiration

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INTRODUCTION

The underrepresentation of women in Science, Technology, Engineering, and Mathematics (STEM) fields is present both in the workforce and in higher education in the United States. Men outnumber women in the number of full-time workers with science degrees, and in both undergraduate and graduate STEM programs (Iwasaki, 2015; Hill, Corbett, & St Rose, 2010). Furthermore, the number of women pursuing masters and doctoral degrees in STEM remains fewer than the number of men (National Science Foundation, 2015; Hill et al., 2010) due to the leaky STEM pipeline in academia (Cameron et al., 2016; Goulden et al., 2011). The need for a robust STEM workforce motivates the need to increase these numbers, and the low numbers of women seeking and completing science degrees can partially explain the underrepresentation of women in STEM careers (Espinosa, 2011; Ong et al., 2011).

According to Espinosa (2011), our society cannot solely focus on changing the numbers without justification. Namely, our intellectual capacity, and, therefore, our ability to innovate will improve through the incorporation of varied perspectives. Our economy can only expand by the inclusion of diverse perspectives, whether in STEM or otherwise (Ong et al., 2011). Women are proportionally underrepresented in STEM fields in both degrees earned and careers held (Iwasaki, 2015; Ong et al., 2011). It is detrimental that women are not fully represented in STEM, because diversity in person represents diversity in thought, which can propel scientific discoveries and lead to novel inventions and methods (McLeod et al., 1996). Incorporating inclusive practices with recruiting towards diversity leads to academic excellence and propels research forward (Stewart & Valian, 2018). There is an apparent need for a diverse STEM workforce, because varied, unique perspectives lead to solutions that apply to a breadth of populations and situations (Espinosa, 2011). According to Ong et al. (2011),

> Failure to advance the education of women of color and move them into productive STEM careers represents a failure of the United States to maximize our own talent pool at a moment when we can ill afford it—socially, technologically, or economically (p. 173).

It is imperative that the STEM workforce reflects the population, because if it does not, the entire population cannot and will not be served. The current study seeks to understand the experiences of women studying and working in the field of Biomedical Informatics in order to better understand as well as improve their experiences in their department through a participatory research method.

Biomedical Informatics is unique in that it is an interdisciplinary field that involves aspects of both biomedical engineering and healthcare informatics, each of which is also multidisciplinary (Kane, & Brewer, 2007; Patel, Yoskowitz et al., 2009).

Biomedical Informatics (BMI) is an amalgam of information technology and informatics, computer science and biomedical sciences, and healthcare and medicine which applies informatics principles to biological problems (Guy, 2020; Kulikowski et al., 2012; Luscombe et al., 2001). As such, there is a dearth of research on the under/representation of women in BMI, in part because it is a novel, interdisciplinary discipline. Therefore, exploring the underrepresentation of women in the fields that are combined within BMI is necessary to understand the unique position of women in the field.

Although there is a lack of research on women in BMI, the literature surrounding women in similar and adjacent fields demonstrates a stark underrepresentation as well as poor experiences in male-dominated fields. Women are frequently underrepresented in such careers as Informatics and computer science (the most closely related fields to BMI), (Schinzel, 2017). In informatics in particular, men greatly outnumber women, and this is increasing in information technology education (Wagner, 2016; Boschetto & Cortesi, 2009). Within computer science research, there is a prevalent gender gap between men and women in terms of research activity and publishing (Agarwal et al., 2016). In fact, the number of women represented in the computer sciences has historically been decreasing—from 30.4% to 16.7% of women entering computer science programs from 1981 to 2008 (Marín et al., 2008).

Within another related field to BMI, engineering, there are a variety of barriers that women in engineering face which impede their success. These barriers include stereotyping threats, discrimination in the workforce, and unconscious bias (Cadaret et al., 2017; Mozahem et al., 2019; Strachan et al., 2018). In general, the biomedical sciences are 'friendlier' for women as compared to informatics, engineering, and the computing sciences, but barriers still exist. Balancing professional and family obligations is particularly difficult for women in the biomedical sciences, and barriers such as these impede the advancement of women in biomedical careers (Barfield et al., 2016; Thibault, 2016).

While the experiences of women within related fields points to similar experiences in BMI, more research must be carried out to determine the specific barriers and hurdles that women in BMI face. In order to fully capture the voices of women in BMI, the current study utilizes Group-Level Assessment, a participatory method which allows for all stakeholders' experiences to be taken into account. Group-Level Assessment allows groups to not only create but also to analyze data in a participatory setting, empowering participants and providing them with autonomy over the data and implementation/dissemination of said data (Vaughn & DeJonckheere, 2019). Group-Level Assessment has been implemented successfully in terms of creating and following through with action plans with elementary school students (Vaughn et al., 2011), STEM faculty (Guy, 2017), women of color in a psychology graduate program (Guy & Boards., 2019), undergraduate women in engineering (Arthur & Guy, 2020), as well as BMI graduate students and faculty (Guy, 2020). In the current project, Group-Level Assessment is employed with women in a BMI department in order to better understand their experiences, as

well as to create a salient action plan towards improving those experiences in collaboration with the women.

METHOD

Data was collected via Group-Level Assessment at a Biomedical Informatics (BMI) department that is run through a large, Midwestern university in the USA, in collaboration with a children's hospital research facility. Participants of the Group-Level Assessment included women working in the department.

Participants

Research participants were recruited from a pool of all the women faculty, staff, and graduate students in the BMI department. As a whole, women make up less than 25% of the department, which consists of majority men. The 45-person pool included 34 staff members (part-time and full-time), three faculty members (including joint- and dual-appointment faculty members), and eight graduate students (i.e. any graduate student working under a BMI faculty member, both within and outside of the BMI graduate program). Participants were recruited via an email message describing the purpose and intent of the study, as well as expectations of participants. Lunch was provided during the data collection process as an incentive to participation. Out of the 45 women in the department, 15 volunteered to participate. Of the 15 women who participated, there were 11 staff members, one faculty member, and three graduate students. Although I am the lead researcher and project facilitator, I was also a BMI staff member at the time of this study. In order to maintain the research integrity and conduct an unbiased study, I was not a member of the participant pool and did not engage in the Group-Level Assessment as a participant, but as a facilitator (see Positionality Statement in Box 1).

Box 1: Positionality Statement

I am personally invested in the current topic for two reasons: the first is through my past experiences as an undergraduate woman in STEM. As a woman in STEM, I faced several challenges that I felt could have been overcome by better action planning and leadership. As an undergraduate woman, I frequently felt intimidated by some of my male professors and feared approaching them. I was told time and time again not to pursue a graduate degree in STEM if I planned on getting married or having a family. These comments infuriated me, as I had a sinking feeling that this same advice was not being given to my male peers. I recall a defining moment in one of my chemistry labs, when a male lab partner assured me that he would do the work and I could just "sit there and look pretty." Although I did end up graduating with a STEM baccalaureate degree, I kept hearing this voice in my head that told me I was not good enough.

The second reason for my investment in this study was my role in the BMI department. At the time I conducted this study, I was working full-time for the BMI department as a staff member. While I have since left BMI, I am still a full-time staff member at the university, working in faculty development. My role at

the time of the current project was in the education program as the Education Director/Graduate Program Coordinator, running the administrative aspects of the Masters and Doctoral programs, as well as advising students on the logistical aspects of their programming. In my role, I often noticed not only the underrepresentation of women in the department but also the frequent discrimination and microaggressions against women in BMI.

Group-Level Assessment

Group-Level Assessment (GLA) is a research method that involves a participatory, reflective process to gather large amounts of qualitative data in a relatively short time frame, as the typical GLA process takes about two hours from start to finish. In general, the GLA process includes participants responding to and reflecting on a set of prompts, conducting a preliminary thematic analysis of prompt responses in small and large groups, and developing an action plan in response to the consolidated themes (Vaughn & Lohmueller, 1998; Vaughn & Lohmueller, 2014). The seven steps of a GLA include Climate Setting, Generating, Appreciating, Reflecting, Understanding, Selecting, and Action (Figure 1).

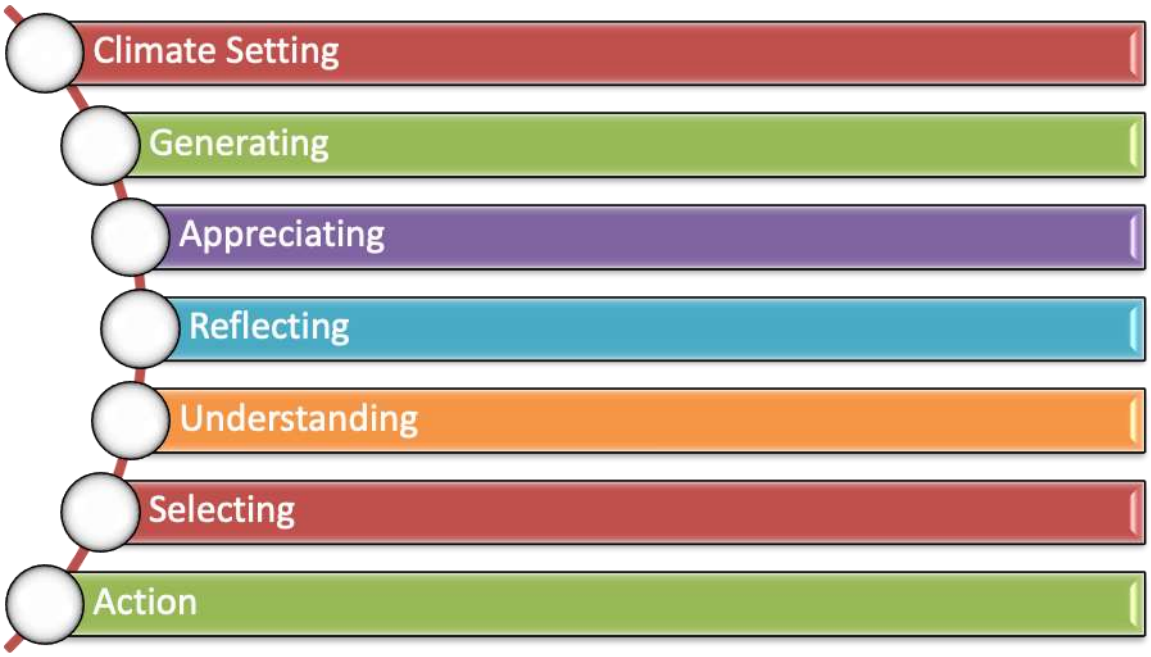

Figure 1: Group-Level Assessment Steps

The GLA with women in BMI began with the Climate Setting step in which I introduced the GLA process and facilitated an ice-breaker activity, so that all the women could get to know each other and become more comfortable with the GLA process. Next, during the Generating phase, I asked the women to respond to a series of prompts that were posted on large poster paper around the room. Prompts were all open-ended and included both positive experiences as well as experiences where women struggled in the BMI department, such as "What I love about being a woman in BMI" and "I wish I had less _____ as a woman in BMI" (see Box 2 for a full list of GLA prompts).

Box 2: Group Level Assessment Prompts

1. What I love about being a woman in BMI.
2. What I dislike about being a woman in BMI.
3. Barriers I face as a woman in BMI include … .
4. If women in BMI had a theme song, it would be _____.
5. The department needs to change _____ to support us as women in BMI.
6. The department needs to keep doing _____ to continue supporting us as women in BMI.
7. I wish I had more _____ as a woman in BMI.
8. I wish I had less _____ as a woman in BMI.
9. What I envision about my future as a woman in BMI:
10. If I could give other women in BMI one piece of advice, it would be … .
11. Words that describe my encounters with my female coworkers in BMI are:
12. Words that describe my encounters with my male coworkers in BMI are:
13. My supervisors can support me by _____.
14. I chose to work at the BMI department because … .
15. The BMI department's biggest strength is:
16. One thing I would change about the BMI department is:
17. I wish I knew _____ about my fellow women in BMI.

During the Appreciating step, I instructed participants to walk around the room and read everyone's responses, drawing stars next to responses they agreed with or that resonated with their experiences in BMI. Next, the Reflecting phase involved the women jotting down their initial thoughts about the overall prompt responses. In the Understanding phase, participants were broken into small groups and assigned a series of prompts. In their small groups, the women identified between three and five common themes, or similarities, *across* their assigned prompts.

The women then returned to the large group for the Selecting phase, in which the small groups took turns sharing their themes out. The large group then worked together with myself as the facilitator to combine and again consolidate these themes into between three and five overarching themes. Finally, during the Action step, the large group discussed what steps could be taken to address the identified themes. Table 1 (below) includes each group's themes, the final combined themes, and the identified action step.

Table 1: Group Level Assessment findings with women in Biomedical Informatics department

Group 1 Themes	1. Need more women in all roles 2. Women are strong and supportive 3. More communication 4. More tools for communication 5. BMI is always changing 6. Women's work should be recognized more
Group 2 Themes	1. Interactions 2. Growth and development

	3. Inclusion 4. Work-life balance
Group 3 Themes	1. Communication between women is more helpful than with men 2. More social interaction
Group 4 Themes	1. Wanting inclusion 2. Office is too cold
Final Combined Themes	1. Introduce and foster more interaction among women 2. Integrate more inclusive practices that involve women 3. Incorporate inclusion/microaggression training in the department
Identified Action Steps	1. Start intentional conversations—most interactions are just passing 2. Internal newsletter 3. Create events/space for social interaction 4. Inclusion & microaggression training

Following the GLA, I conducted a second round of qualitative coding and carried out a thematic analysis. I took the participants' themes into consideration as I developed my own coding system and determined final themes.

FINDINGS

Key themes that arose from the participants' thematic analysis and my additional coding included: (1) Isolation, (2) Inclusivity (lack of), and (3) Inspiration. Table 2 includes descriptions of the three main themes with representative quotes.

Table 2: Group Level Assessment key themes

Theme	**Description**	**Representative Quote**
Isolation	Lack of interaction in the department leads to feelings of isolation	"Nobody says good morning or even says 'hi' "
(Lack of) Inclusivity	Need for the department to be more inclusive for women	"Sometimes [I] feel left out of the camaraderie between the guys"
Inspiration	Feeling inspired by the collaboration and creativity within the department	"The women here are strong and supportive"

Theme 1: Isolation

The women indicated that they frequently feel isolated in the department, and wish they had more interaction with both men and women. Many of the participants agreed that working in BMI "can feel lonely" and they feel the department "need[s] more communication" between its employees. As one woman explained, "talking [is] replaced by messaging," which led to much agreement, with another woman sharing that "nobody says good morning or even says 'hi'." In general, within the BMI department, most participants felt that "feeling isolated" is typical as a result of "no communication or friendly relationships."

In terms of their relationships with other women in the department, "[There is] no talking amongst women. The women are more spread out. There are physical barriers of the cubes." In addition to the lack of communication with their fellow women, participants also felt that there are "more interactions happening between men," and in one case a woman experienced the men in the department "play[ing] a game and [leaving] women out." Another woman agreed, stating, "sometimes [I] feel left out of the camaraderie between the guys." In the future, participants indicated that they hope for "more women in the department and more interaction" so that they can begin "getting to know others [in the department] better."

Theme 2: (Lack of) Inclusivity

Participants felt that the department is not inclusive towards women, which is borne out and compounded by the low percentage of women in the department. During the GLA, women agreed that they wish they had more "feeling of inclusion" within the department. This could manifest in increasing the number of women by "hiring more women," as well as appointing "more women in leadership roles," as participants felt they have "no female role models." A much-agreed-upon prompt response during the GLA was that participants wished BMI had "more women and [a] more inclusive community." As a result of this lack of inclusivity, women in the department "feel pressure to talk softly or to not talk at all."

Another aspect of inclusivity that the women felt could be improved upon is inclusive practices "allowing more work/life balance." The women agreed that they would like their supervisors to support "flexibility with child duties" by "not expecting [us] to work during family time." Furthermore, in the future, the participants would like to see an implementation of "women-centric activities or events—like this one!"

Theme 3: Inspiration

Despite the challenges women in the BMI department face as a result of feeling isolated and a lack of inclusivity, there were many positive items shared relating to working in the department. Many of the women agreed that they felt inspired working in an "ever-changing environment" because there is "always something new to learn." There was a general consensus that working in the BMI field is a "great opportunity" as it is a "culminating point of all departments [with] people from diverse backgrounds." Multiple women indicated the strong collaborative environment in BMI, filled with "innovative thinkers with big ideas and goals."

The participants also felt inspiration from their passion for the field and what they can do with their experiences in BMI. One woman explained she "want[s] to make a difference" with her work in BMI, and another stated she is passionate for the field and "love[s] research and technology." Although lack of communication between women is seen as an issue in the department, one woman brought up that "the women here are strong and supportive." Ultimately, the women would like the department to capitalize on its strengths in order to address its weaknesses, as one woman so succinctly put it: "BMI is always changing and offers opportunities, but we would like more—especially for women."

ACTION & FUTURE DIRECTIONS

Isolation, (lack of) Inclusivity, and Inspiration were three key themes identified throughout the GLA data. Not only was the data from the prompt discussion and the discussion analyzed, but the women also developed an action plan as a result of the issues that surfaced. Several of the proposed action steps were implemented within six months of the group meeting.

Actions Identified

The women agreed that starting intentional conversations needed to be one of the first action steps addressed, as "most interactions are just passing." One suggestion was to continue to meet with the GLA participant group, and as such another meeting was scheduled for the next month so that we could continue to keep in touch and work towards our goals. The group also felt it would be helpful for us to eat lunch together when available and decided to communicate with each other via a group chat to set up informal lunch meetings.

Another idea that came up was to create an internal newsletter in order to get to know one another and learn about each other's work and hobbies. The women felt that spotlighting individuals, including personal activities and information, would help build a sense of camaraderie within the departments and foster connections between employees. The participants agreed that utilizing the newsletter to acknowledge important events in employees' lives, such as birthdays, weddings, and the birth of children, would allow for more individuals to be highlighted and included. This idea was presented to the BMI leadership and communication team, and a monthly newsletter was developed.

Implementing microaggression training was also brought up as a potential action item. The women explained that their male colleagues are often "creepy," "weird," and "sometimes rude," and that it would be beneficial for the department to "teach best practices." To address this, steps were taken to introduce microaggression training in the department. In fact, within six months of the GLA with the women, a microaggression training session was presented to graduate students within the department hosted through the university's Office of Equity and Inclusion.

Future Directions

Limitations of this study include the small sample size and lack of diversity within the group. Within STEM fields, women of color face discrimination at a higher rate than white women, with more detrimental outcomes as a result of being part of two marginalized groups (Espinosa, 2011). Women color in STEM face more structural and systemic barriers that negatively impact their STEM participation than their white and male counterparts (Ong et al., 2011). Within engineering in particular, people of color are disproportionately underrepresented, and women of color face a number of challenges in terms of their persistence and performance in STEM (Ross et al., 2017; Ross & Godwin, 2016). Future studies should address the specific experiences of women of color in BMI due to their intersectional identities and unique experiences as a result of their marginalization.

Furthermore, a comparative study that considers the career tracks of men and women in the BMI department would be beneficial to measure. In interdisciplinary areas if men are from the computing or engineering disciplines, and women are primarily from biological sciences, issues of professional respect might emerge. Future research to understand these discrepancies and minimize discrimination would be valuable.

Next steps for programming and action planning in particular, would involve reporting the experiences of women in BMI to senior leaders in order to engage them and support leadership by embracing diversity in the field. Additionally, engaging with professional societies to access best practices and collaborating (with men as allies) on professional development opportunities for women in BMI could help minimize some of the issues women in BMI face.

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