

An Intergenerational Working Conference to Define Research Questions for Future Work on Women's Success in STEM

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Abstract

Many of the scholars who have been working in the area of women in the Sciences, Technology, Engineering and Mathematics (STEM) are now approaching retirement. At the same time, new themes and issues are emerging from the next generation of scholars. To date, no gathering has brought these two generations together with the express purpose of comparing research themes and evaluating findings. In this paper the authors present results of a qualitative study that was conducted to provide structure, implement, and evaluate a working conference on Women's Success in STEM. Fostering intergenerational and interdisciplinary dialogue on workplace factors associated with women's success in STEM via the working conference led to a collective effort to define research priorities for the years to come.

Background

The overall goal of the Working WISE (Women in Science and Engineering) project, located in the Center for Women and Work at the University of Massachusetts Lowell (referred to Umass Lowell in the rest of this manuscripts) is to create an intergenerational response to the challenges of advancing women in STEM (Science, Technology, Engineering and Mathematics) fields by facilitating dialogue that will lead to the articulation of priorities for future research and policy and enhance our understanding of these challenges. The heart of the initiative is a working conference bringing together an intergenerational and interdisciplinary community of racially and ethnically diverse scholars and scientists. Specific objectives of the conference include: 1) promoting exchange and collaboration to better understand the impact of workplace factors on women in STEM fields; 2) synthesizing current research findings; 3) identifying new research themes and questions that will further understanding of these issues; and 4) disseminating results of the interdisciplinary, intergenerational analysis of research to a broader audience concerned with workplace issues for women in these fields. Activities to achieve these objectives have taken place in five major phases: 1) groundwork, 2) a collaborative conference planning process, 3) the invitational working conference, 4) preparation of concept papers resulting from the conference and compiling them into an edited volume, and 5) dissemination (diffusion) of conference results. Structure for the working conference was provided by a citation analysis, a literature review and a Delphi Study, all of which were initiated in the first year of the project, during 2006.

Citation Analysis

The citation analysis was conducted to identify what scholars have been writing about workplace barriers for women in STEM fields and which of these have been most frequently cited by others. This analysis covered 20 major databases, both general databases and those in STEM and social/psychological fields. Items from 1975-2005 were collected. All citations were stored in Refworks and sorted by year and database. The senior researchers on the project indicated which citations were to be investigated in more detail and all items so designated were searched in Web of Science for a yield of 1,036 items. The PI for the Project identified key articles for which number of articles by each author and number of citations was computed. From an initial list of 87 key articles 52 were chosen as subjects for the Literature Review.

Literature Review

After conducting a careful literature review of the key 52 articles, five themes emerged as most prominent in the research: Educational Preparedness; Employment and Career Prospects; Discrimination; Work-Family Issues; and Relevant Policies. Three themes however were clearly more prominent than the rest in the following order: Work-Family Issues, Culture of the Workplace (Issues including informal and formal patterns of mentoring, networking and discrimination) and Public and Private Policies Affecting the Workplace. These three themes were selected as relevant themes for discussion at the conference. Results from the Delphi Study were added to the literature review results in order to obtain the final conference thematic structure. In addition to those themes, it is important to note that our research documented that “STEM” fields and specific workplaces do not offer monolithic experiences, and that there are both similarities and differences between STEM fields and other professions. Also, as it was noted that women’s experiences are not monolithic (i.e. due to factors of race/ethnicity and class).

Delphi Study

Principles of content analysis and the Delphi methodology were applied in structuring the content for the conference. Such methodology included the establishment of an advisory panel of experts, the development and implementation of 3 semi-structured questionnaires, and a face-to-face meeting among the panel of experts. All the qualitative analyses of the data were conducted using NVivo©, a software package designed for analysis of complex, non-structured qualitative data which allowed for the analysis of emerging themes from the compiled data.

The Delphi method was chosen due to its capability of facilitating the process of gathering opinions from a group of experts who share a common interest but usually represent different points of view. The method is based on a structured and iterative process for extracting knowledge from a panel of experts via a series of questionnaires with controlled opinion feedback. The Delphi method improves the generation of critical ideas by structured collection of information and processing of the collective input from a panel of geographically dispersed experts. By facilitating communication between and among a panel of experts the process is effective and the group as a whole can deal with a complex problem (Linstone and Turoff, 1975). *Selecting the Panel of Experts:*

Criteria for being selected as a member of the Delphi Panel of Experts included: to belong to one of the two generations of scholars working in the Women in STEM field; to have participated in related research initiatives as principal investigator, co-investigator, or senior personnel; to have published in major related journals; and to belong to diverse racial/ethnic groups. Our outreach efforts provided a total of 12 experts that agreed to participate in the study. It should be noted that the majority of Delphi studies have used between 15 and 20 respondents⁶. The gender distribution of the panel was 1 male and 11 female. Half the participants belonged to the first and the other half to the second generation. With the exception of one participant who reported being engaged on research for more than 6 but less than 10 years, all participants reported to have been engaged on such activities for more than 11 years. STEM disciplines represented by the panel included Physics, Computer Sciences, Environmental Sciences, Engineering, Life/Biological Sciences, and Social Sciences. Current job positions reported by the panel included professor (assistant, associate and full), dean, director (academic program), director (non-profit organization), consultant and senior consultant.

The Delphi Stages:

Our study involved two rounds of questions and a group meeting. It was conducted over a period of approximately 2 months. Responses from the first questionnaire were summarized to form the basis of the second questionnaire. Responses from the second questionnaire of this Delphi study were discussed at a 1-day meeting where the experts of the panel were brought together. This meeting (August, 2006) served as a preparatory meeting for the Spring 2007 working conference, “Intergenerational Voices on Women in Science and Engineering”. The working conference aims to create an intergenerational response to issues of advancing women in STEM (Science, Technology, Engineering and Mathematics) fields and to create proposals for future research and policy on related themes. The format of the conference is expected to include small intergenerational and interdisciplinary teams, each focusing on one of the themes identified through the Delphi process presented here.

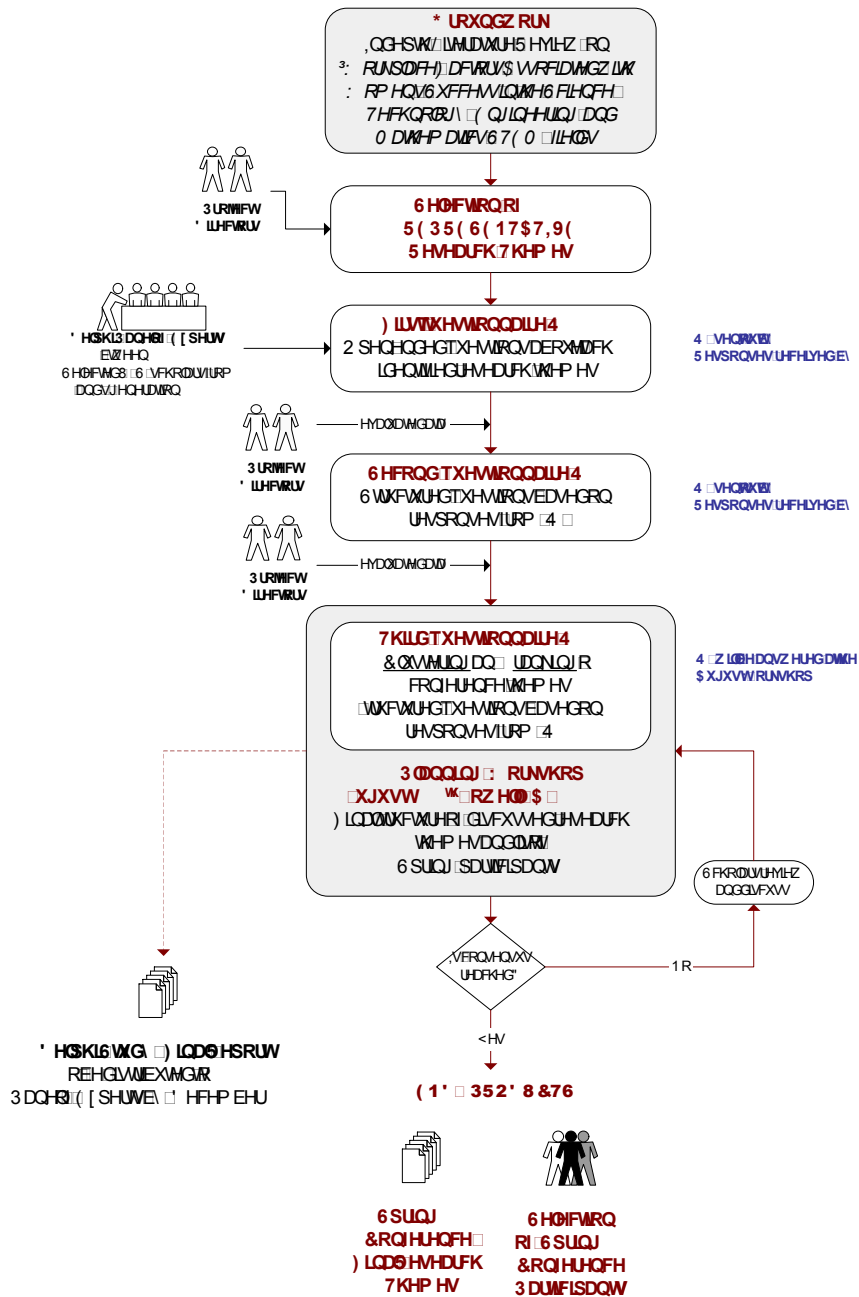
The different stages of the applied Delphi method are shown in Figure 1. A first questionnaire with a few open ended questions was distributed to a list of scholars identified using the criteria explained above. The first questionnaire focused on general issues related to the attraction, retention and advancement of working women in STEM fields. Specific themes included job design and organizational factors; work family balance; work climate; diversity and equality; discrimination; quality of working life; and external factors to the work environment including national policy issues.

The first questionnaire received very thoughtful and detailed answers. All the responses obtained were analyzed, and, based on the outcome of the analyses, various clusters of information were identified. A second questionnaire that integrated the panel members’ responses was designed. The questionnaire mainly asked for a level of agreement on each of the selected questions and themes. Both questionnaires are available upon request. After distributing the second questionnaire instead of requesting the answers via email the group of scholars was gathered in a 1-day preparatory meeting to discuss the group responses. This meeting took place in August 30th 2006. The proposed face-to-face meeting was essential in order to provoke dialogue among and between the two generations of scholars from the panel of experts and to provide participants with a deeper understanding of each other’s opinions. At the end of the meeting, two

open-ended questions (third questionnaire) were asked to all participants. These included What is the most critical thing learned on the Delphi process and preparatory meeting?, and What is the most relevant issue that we would not want to miss at the Spring 2007 Conference?. All the responses were collected and gathered in a document labeled ‘summary’. The entire meeting was audio-recorded and its 48-page transcript together with the ‘summary’ were part of the materials later analyzed using Nvivo (Brunette et al, 2007).

Qualitative Results:

Table 1 displays the main node structure (level 1) with the information of passages coded for each major node. Overall, there were 11 major nodes and 58 sub nodes. The 11 node-structure (level 1) had a total of 607 coded passages which included 703 coded



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Figure 1. Flowchart of Delphi Study.

paragraphs with a total of 151,141 coded characters. The nodes with the largest amount of coded passages were N1, N6, N8 and N5 respectively. The complete coding report which includes the 607 passages coded arranged based on the node structure is also available upon request. The main node structure as shown in Table 1 provided a framework of the different topics that were brought up by the panel. Each of the nodes in level 1 represents the attempt to categorize the vast amount of information that was gathered from the panel.

A Pareto Analysis (80%/20%) was conducted to help arrange and prioritize the vast amount of information gathered from the qualitative analysis. This was done calculating the percentage and cumulative percentage of the number of passages coded for each node and sub-node. By arranging the information obtained from the Pareto analysis it was found that Nodes 5 (work family balance), 6 (practices and policies) and 8 (organizational factors) were the ones demanding further attention. Although Node 4 (discrimination) did not have a large number of coded passages, the issue of discrimination was intrinsically part of the discussion among the panels and was considered an important issue for further discussion. Based on the results obtained, it was expected that the structure of the conference will consider the themes work family balance, job and organizational factors, discrimination, and practices and policies. After a team discussion it was agreed that practices and policies was a common denominator of the first three, consequently it was dropped. Considering the results from the Literature Review, the theme of Educational Pathways was added to the final thematic structure. The final four selected themes were Educational Pathways for Women in STEM Fields, Job and Organizational Factors, Work-Life Balance, and Work-based Discrimination.

Nodes (level 1)	Passages	%
N1 - Major changes for women in STEM	123	20.3%
N2 - Competitive future work environment	56	9.2%
N3 - Social and cultural expectations	47	7.7%
N4 - Discrimination	33	5.4%
N5 - Work family balance	75	12.4%
N6 - Practices and policies	82	13.5%
N7 - Job design	12	2.0%
N8 - Organizational factors	76	12.5%
N9 - Evaluation methodologies	29	4.8%
N10 - Conference structures	24	4.0%
N11 - Miscellaneous	50	8.2%
Total coded paragraphs	607	-

Table 1. Main Node Structure: Passages Coded.

Conference Implementation & Immediate Outcomes

A truly collaborative conference planning process was carried out faculty, staff and graduate students on the Working WISE team at UMass Lowell in collaboration with our NSF project officer, a national advisory board made up of a diverse intergenerational group of national leaders and scholars in the field, and a UMass Lowell Advisory Council with representatives from the engineering, science, and social sciences faculties as well as from the university administration and libraries.

A unique approach for promoting intergenerational interdisciplinary dialogue at the conference used inclusive criteria in the selection of conference participants based on generation, gender, racial and ethnic background, and discipline, as well as the sector in which nominees are employed (i.e., academia, industry, government or non-profit sector). The original goal of bringing together a diverse group of scholars was expanded to include professionals working in STEM fields with an interest in the conference themes. Nominations were achieved through an iterative process in which advisory board and advisory council members, Working WISE team members and our NSF project officer were all asked for nominations of people they thought would contribute to the conference who were then sent invitations. These nominees (whether they accepted or declined the invitation) were asked for further nominations, specifying the diversity criteria we were wishing to achieve. Over 220 invitations were sent out as part of the process, known in the social sciences as the “snowball” technique, which resulted in a database of names with contact information and the diversity criteria listed above for each invitee. Eventually, there were 98 participants locally– including UMass Lowell– and from across the country and, who participated in the conference. They came from 13 states, Washington DC, Puerto Rico and Sweden, representing many fields including engineering, chemistry, biology, physics, computer science, information technology, sociology, psychology, education, political science, economics and many more.

The original grant proposal was based on a standard conference format. However after much discussion of what we hoped to achieve at this working conference and input from our Advisory Board, an entirely original, ambitious and new format was developed based on a Request for Proposals (RFP) framework. The revised goal was to create diverse intergenerational visions for action (DIVAs) to promote the advancement of women in science, technology, engineering, and mathematics fields (STEM). To accomplish this goal, we organized participants into eight small intergenerational and interdisciplinary teams, each focusing on one of the four themes delineated above. The assignment of participants to working groups was based on professional experience, participants declared interests, and generation (1st: 65 years and over, 2nd: 40-65 years, or 3rd: 40 years and under). Group assignments also represented diversity in sex, field, race and ethnicity and employment sector. Each participant was sent a packet of materials in advance to prepare for the conference, which included a description of the conference format, two general articles, one from 1965 and one from 2005, to provide historical markers that set up the contextual, intergenerational frame for the conference, as well as 2 articles for the theme topic to which each participant had been assigned. Each collaborative group discussion was organized around the RFP format, in which participants worked to put together proposals for future research, public policy, and workplace action. The discussions were led by trained facilitators and recorded by trained notetakers from UMass Lowell (backed up by audio recordings). At the

end of the day a member or members of each group volunteered to write a brief concept paper incorporating the proposals from their group. Evaluations completed by conference participants were generally very positive. Respondents appreciated the immense level of attendee participation and the diversity in the approaches of individuals in their groups.

The intergenerational, interdisciplinary invitational working conference “Intergenerational Voices on Women in Science and Engineering” took place at the University of Massachusetts Lowell on April 25th and 26th, 2007. An evening event on April 26th provided an opportunity for our project team, our national advisory board members and our UMass Lowell advisory council members to meet one another and to have some advance discussion on the themes of the conference. The evening also set the climate for innovative thinking through design-game activity. The all-day conference on April 26th included a welcome and introduction from the Working WISE team and university officials, three working group sessions, and a final plenary session with feedback from each of the groups, followed by a concluding address from keynote speaker Dr. Evelyn M. Hammonds, Professor of the History of Science and of African American Studies and Senior Vice Provost for Faculty Development and Diversity at Harvard University. The day ended with a reception which provided the opportunity for informal exchanges and networking among conference participants.

Immediate Outcomes- Group Concept Papers:

Our one-day gathering resulted in outlines for 2 or 3 concept papers for each of the four themes (a total of ten papers—see Table 2 for titles and proposed research questions). At the end of the conference day, we asked for volunteers to author/co-author an extended version of these concept papers, which we plan to pull together

Concept Papers & Research Questions

Theme A: Educational Pathways for Women in STEM Fields

Group #1: Questions and Methods for Investigating Barriers in Educational Systems

Group #2: Institutionalizing Institutional Change: The Systematic and Sustained Promotion of Women in STEM

Group #3: What information exists about promotion, interest and equity at all levels of STEM education for females (girls and women, pre-K-12) that has not been disseminated effectively to the end-users?

Theme B: Job and Organizational Factors

Group #4: How communities function in supporting successful working scientists and engineers: Identifying factors in the job, the community and the organization

Group #5: Supportive Communities for Women in Science Technology and Math Fields.

Theme C: Work-Life Balance

Group #6: The Economic Benefits of Work-Life Policies in Industry and Academe

Group #7: Creating a Guide to Inform Policies that Foster Work-Life Balance in STEM Institutions

Theme D: Work-based Discrimination

Group #8: Work-Related Discrimination: An Early Beginning, but Where is the End? Following Discrimination from K-20 Education into the Workplace

Group #9: What forms of work-related discrimination still exist? Do the dynamics of discrimination vary according to STEM field and, if so, how do they vary? What have we learned about the characteristics of work environments that discourage discrimination? In what ways are women resisting discrimination and working to change the culture in STEM workplaces?

into an edited volume. To date we have received drafts of 9 of the 10 papers, as well as a paper from our keynote speaker at the conference, Dr. Hammonds. We are currently focusing on reviewing and editing the concept papers, doing the necessary additional background research to fill out the content of the papers and bring the research up to date and, finally, producing a published volume as a product to reflect this imaginative Research-Action and Intergenerational Conference process.

Diffusion:

Diffusion activities are aimed at bringing the entire endeavor to a wider audience and creating momentum for future research and policy initiatives. Outreach to academic, industry and public policy audiences will be achieved through presentations at conferences and workshops, as well as at more informal gatherings, submission of journal and newsletter articles, and a project website.

Major contributions

The potential impact of this project is very broad. The interdisciplinary, intergenerational exchange which took place at the conference and the resulting concept papers break new ground and we hope will stimulate future collaborative research. Contributions to the field include: 1) a

well-organized analysis of what has been learned from three decades of previous research in a wide range of disciplines about the attraction, retention and advancement of women in STEM careers; 2) the articulation of the next generation of interdisciplinary questions to guide research, practice and policies in this area; 3) increased dialogue among scholars and scientists from 3 distinct age cohorts which can inspire further cross-generational collaboration; 4) scholarly publications and presentations which inform the broader research and occupational communities about workplace-related factors that affect the status of women in STEM; and 5) the development of an innovative working conference format based on a RFP proposal conceptual framework. In addition, the entire project is multidisciplinary in nature as reflected in the key personnel on the project as well as by the widely diverse fields of our advisory groups and conference attendees.

The citation analysis, literature review and Delphi process have established new learning about the use of these methods in research and education. The edited volume of concept papers represents an important articulation of a future innovative research agenda for understanding the issues faced by women working in STEM fields. The compilation of concept papers from the conference and our diffusion activities are aimed at bringing the entire endeavor to a wider audience and creating momentum for future research and policy initiatives in the social science, education and public policy arenas.

References

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