Changing teachers' views of engineers

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ABSTRACT: This article describes a workshop activity the author has carried out with 80 high school science teachers to enable them to overcome their stereotypical perceptions of engineers and engineering. The activity introduced them to the biographies of prominent women in engineering, and raised their awareness of these female engineers' contributions to engineering and society. The results showed that the activity was effective in dispelling the participants' perceptions of engineers as men. For example, the percentage of participants who depicted engineers as men decreased from 96.3% before the intervention to 48.8% after the intervention. The results also showed that the activity was effective in countering the participants' perceptions of the nature of engineering jobs. By providing detailed information about the personal lives and work experiences of the female engineers, the biographies might be useful in countering existing cultural stereotypes of female engineers and initiating changes in perceptions needed to narrow the gender gap in engineering.

INTRODUCTION

The perception that engineers and scientists are intelligent Caucasian men who are socially inept and absent-minded people seems to be prevalent among students of all levels, from elementary school to college [1][2]. While the media may, by chance or choice, promote this image, it is unfortunately a realistic one. For example, while women constituted 47% of the general workforce of the USA in 2006, they represented only 26% of the engineering and science workforce [3]. This stereotypical image of engineers and scientists as Caucasian men has, in part, discouraged many young women from pursuing any interest they might have had in an engineering or a science career because they do not want to (and cannot) be the people so often portrayed in the media [4].

Stereotypical images of engineers and scientists have contributed, in part, to the existing gender gap in engineering and science [1]. This gender gap can be traced back to the educational choices made by young women. Statistics show that women in the OECD countries earn fewer bachelor's degrees in most engineering and scientific fields as compared with men. For example, in 2003, women earned only 13.8% of all bachelor's degrees in engineering in Switzerland, 18.7% of all bachelor's degrees in engineering in UK, 21.0% of all bachelor's degrees in engineering in the USA, and 29.1% of all bachelor's degrees in engineering in Sweden [3].

The gender gap in engineering and science has also been attributed to a number of other factors. Girls' rejection of engineering and science can be partially driven by parents, teachers and peers when they subtly, and not so subtly, steer girls away from informal technical pastimes (e.g. fixing bicycles) and science activities (e.g. science fairs) that too often are still thought of as the province of boys [5]. Another reason is the shortage of female role models in engineering and science, and this is because female engineers and scientists are severely under-represented among senior positions in academia, government and industry.

With this dearth of female role models, many girls do not see themselves as successful doers of engineering and science, and tend to view these disciplines as unsuitable careers and irrelevant to their lives [6]. A similar reason is the shortage of female mentors in engineering and science. Having a mentor is critical to advancing into senior positions in corporations. However, it may be difficult for female engineers and scientists to find mentors through the same informal mechanisms used by men, especially, since individuals tend to mentor people who are very much like them. Hence, female engineers and scientists are at a disadvantage in a predominantly male environment [1].

In addition, female engineers and scientists with spouses and children struggle to keep up with the fast-paced work environment. Unlike men, women remain primarily responsible for child care, elder care and other household responsibilities. Even in corporations with family-friendly policies, women are concerned that they cannot pursue their engineering and science careers and take family leave simultaneously without risking the perception that they are less committed to their careers than their male colleagues [7]. The gender gap in engineering and science can also be attributed to lower pay scales and slower promotion rates for women as compared with men [8]. Female engineers' and scientists' progress early in their careers may be impeded by their having to prove their technical credibility repeatedly. This may be the result of stereotyping of women's abilities by male supervisors, as well as the perception that promoting women is riskier than promoting men. The perception that women cannot do engineering and science is one that female engineers and scientists have to battle constantly. The competencies and traits associated with success in engineering and science are generally viewed as male attributes [1]. Men and women have different styles of communication, and this may also affect how female engineers' and scientists' ideas are received by their male supervisors. Corporations tend to reward an aggressive style of speaking, and often discount language that is not certain. Women who exhibit an assertive style, however, run the risk of being seen as inappropriately combative [1].

Fortunately, research has shown that strategies, such as presentation of female role models, distribution of career information, examination of gender-equitable materials, and participation in hands-on science investigations are effective in countering the perception that engineering and science are unsuitable for girls [9-12]. Research has also pointed to the presence of female role models in engineering and science as the most important factor in sustaining girls' interests in engineering and science.

In order to reach out to students at an early age when they are still impressionable, many universities have recently organised outreach programmes to educate high school teachers about engineering, and hopefully, they will encourage their students to study engineering [13]. Some universities (e.g. Purdue University) have even set up an engineering education department for this purpose. The feedback from such programmes has been encouraging.

For this work, the author wanted to inform teachers about the applications of engineering, to demonstrate the problem-solving approach of engineers, to correct misperceptions of engineers and engineering among teachers, and to provide them with female role models from the various disciplines of engineering. To achieve these goals, the author recently conducted a number of outreach workshop activities for 80 high school science teachers. The teachers were then charged with integrating what they had learned from the workshop into their classrooms.

This article describes one of the workshop activities the author has carried out with high school science teachers to enable them to overcome their stereotypical perceptions of engineers and engineering. The workshop activity introduced them to prominent women in engineering, and raised their awareness of these female engineers' contributions to engineering and society. Teachers and professors can use the examples of these prominent female engineers as role models to inspire their female students who are aspiring to become engineers.

METHOD

The high school science teachers consisted of 45 men and 35 women. The procedure consisted of the following steps in sequential order:

1. Draw-an-Engineer Test;
2. Assigning female engineers to participants to undertake research about;
3. Oral presentation of female engineer and question-and-answer session by each group;
4. Submission of written reports of female engineers;
5. Draw-an-Engineer Test;
6. Post-activity survey to find out what participants had noted about the biographies of the female engineers;
7. Follow-up survey.

The participants were first asked to complete a Draw-an-Engineer Test to assess their perceptions of engineers and engineering. The test required them to draw a picture of an engineer at work [2]. The drawings were analysed as follows. Drawings of engineers with short hair and broad shoulders were regarded as men, while those with long hair and narrow shoulders as women. Drawings of engineers working with one or more of the following items were considered as engaged in building or repairing: hardhat, workbench, heavy machinery, hammer, wrench, car, engine, rocket, airplane, robot, bridge, road, building, train and train track. Those working with a computer, blueprint, pen, model and/or desk were regarded as engaged in planning or designing, while those working with test tube and/or beaker were deemed as doing laboratory work.

The participants were then randomly divided into groups of four members each, and the various groups were each assigned a female engineer from Appendix 1 to research about. Appendix 1 contains 20 prominent women in engineering and their major achievements. The participants were given one week to do their research and were encouraged to use Internet resources for their research. To enable the participants to overcome their stereotypical perceptions of engineers, the female engineers in Appendix 1 were selected with careful thought.

Engineers from different disciplines (e.g. biomedical engineering, chemical engineering, civil engineering, computer engineering, electrical and electronics engineering, materials engineering and mechanical engineering) were selected to help participants view engineers as individuals rather than as stereotypes. The engineers were selected to represent a range of ethnic groups so that the participants could identify with their role models culturally. Some young women avoided pursuing a career in engineering because of a perception of the difficulties of coping with both work and family life. Hence, many examples of engineers who were married and had children were included. It was hoped that, through the use of such examples, potential female engineers would gain some assurance that it would be possible to balance a career in engineering with family responsibilities.

Each group was required to do a 20-minute oral presentation and submit a written report of the female engineer assigned to the group. The participants were required to design and present the following documents to give an overview of the female engineer's life:

1. Birth certificate;
2. Educational certificates;
3. Marriage certificate;
4. Résumé for a hypothetical research post that the female engineer wished to apply.

They were also required to address the following items during the presentation:

1. Who inspired the person to become an engineer?
2. What was the nature of her work?
3. What were her research interests?
4. What were her major research findings, and how had they influenced the current knowledge then?
5. What were the difficulties she had encountered in her work, and how had she overcome them?
6. What were some issues in her life which were unusually inspiring for young women studying engineering?

Each oral presentation was followed by a five-minute question-and-answer session. After all the groups had presented, the Draw-an-Engineer Test was administered to determine the effectiveness of the oral presentations in dispelling the participants' misperceptions of engineers and engineering. The significance of differences in drawings before and after the intervention was assessed by using the McNemar Test for Significance of Changes [14]. A post-activity survey consisting of four forced-choice items was also administered (Appendix 2), and this required the participants to indicate what they had noted about the biographies of the female engineers in terms of:

1. Who inspired them to become engineers?
2. What appointments did they hold?
3. What difficulties had they encountered at their workplaces?
4. How did they cope with both work and family life?

A follow-up survey consisting of one forced-choice item was administered six months later *via* e-mail to find out whether the participants had carried out the activity with their students.

RESULTS AND DISCUSSION

The author observed that the female engineers featured during the oral presentations really captured the attention of the participants. The participants seemed to show greater enthusiasm than anticipated; and everyone participated in the question-and-answer sessions.

The participants commented that administering the Draw-an-Engineer Test at the outset without them suspecting anything was a powerful way to make them become aware of their misperceptions of engineers and engineering. The results showed that before the intervention, the perception of engineers as men seemed to be more prevalent among the male participants as compared with the female participants - all the male participants depicted engineers as men, while 91.4% of the female participants did so. The results showed that the activity was effective in dispelling the participants' perceptions of engineers as men. The percentage of male participants who depicted engineers as men decreased from 100% before the intervention to 62.2% after the intervention ($p < 0.01$). Similarly, the percentage of female participants who depicted engineers as men decreased from 91.4% before the intervention to 31.4% after the intervention ($p < 0.01$). After the intervention, the male participants seemed to be more tenacious of their perceptions of engineers as men than the female participants - the percentage of male participants who depicted engineers as men decreased by 37.8% whereas that of female participants decreased by 60.0%.

In the drawings, the participants showed engineers engaged in building or repairing, planning or designing, or laboratory work. The results showed that the activity was effective in countering the participants' perceptions of the nature of engineering jobs. The percentage of male participants who portrayed engineers engaged in building or repairing decreased from 66.7% before the intervention to 4.4% after the intervention ($p < 0.01$), while that of female participants decreased from 74.3% to 2.9% ($p < 0.01$). Conversely, the percentage of male participants who depicted engineers engaged in planning or designing increased from 26.7% before the intervention to 91.2% after the intervention ($p < 0.01$), while that of female participants increased from 20.0% to 91.4% ($p < 0.01$). Thus, prior to the intervention, a majority of the participants had the misperception that engineering jobs involved a lot of manual work and were physically demanding. The oral presentations enabled the participants to note that engineers were increasingly required to think, plan, design and communicate, and not do just manual work. In order to encourage more girls to pursue engineering, teachers need to highlight to students that in today's knowledge-based and innovation-driven economy, engineering requires intellectual ability and capacity for innovation and not so much manual work.

The participants noted that the female engineers featured in this activity cited the role of their parents or teachers in encouraging their pursuit of an engineering career. Research has pointed out the importance of parental support in fostering young women's interest in science-related careers [15]. Research has also shown that teachers play a critical role in young women's decisions to pursue engineering and science careers [16]. All these might suggest that organising outreach programmes directed specifically at parents or teachers might help to narrow the gender gap in engineering.

The participants noted that the female engineers featured here held senior positions in academia, government or industry. Many of them were recipients of national and international awards and honours. They were different from those the participants had ever encountered and those found in many studies where most female characters were shown as pupils, laboratory assistants or science reporters [17]. The female engineers featured here could, therefore, be used to overcome existing stereotypes of female engineers.

The participants noted that the female engineers featured here acknowledged that they had encountered difficulties at their workplaces. These difficulties included the absence of female role models, mentors and colleagues, male supervisors' stereotyping of women's abilities, differences in communication style between male supervisors and female engineers, difficulty in coping with both family and career, and lower pay scales and slower promotion rates for women as compared with men.

However, they also mentioned recent progress made towards acceptance and equality. The participants felt that although these difficulties truthfully reflected the experiences of the female engineers, such revelations might deter talented young women from pursuing careers in engineering. This is a significant point because a study of high school students shows that young women are less likely to choose careers in science because of the difficulties associated with doing science [18]. The participants felt that while it was important to raise young women's awareness of the chilly environment that might exist in engineering, it was even more important to highlight the improvements made in producing more inclusive workplaces in engineering.

The participants noted that the female engineers featured here were able to cope with both work and family life because of pro-family workplace policies, and having a supportive and understanding husband and an efficient domestic help. This is an important point because concerns about how to balance work and family responsibilities appear to be a recurring issue in research on the factors that keep young women from pursuing engineering and science careers [1]. In order to encourage more young women to pursue engineering, it was thus important to highlight how female engineers successfully combined work and family.

All the participants took part in the follow-up survey. The survey findings showed that 83.8% of the participants had carried out the activity with their students. Further analysis of this result showed that the female participants were more likely to have done so as compared with the male participants - 91.4% of the female participants versus 77.8% of the male participants. This could be because the female participants were able to identify with the role models better than the male participants. All these results indirectly showed that the participants found the activity useful for dispelling their misperceptions of engineers and engineering. Indeed, it is important that teachers do not carry stereotypes with them to the classrooms because research has shown that stereotypes can shape girls' attitudes in ways that limit their educational and vocational aspirations during the early years of adolescence [16].

CONCLUSIONS

This article describes an activity that can be used to correct misperceptions of engineers and engineering among high school teachers. The results showed that this activity was effective in achieving the goals of correcting misperceptions of engineers and engineering among high school teachers, and providing them with female role models in engineering. In future, the biographies of the female engineers featured here could be collated into a book or an on-line resource to showcase these women's contributions to engineering and society. The activity could also be used for elementary and middle school teachers - this might enable them to correct misperceptions of engineers and engineering among their students.

Furthermore, the activity could be carried out by academic staff with female undergraduates or graduate students so as to provide them with female role models - this would encourage them to pursue and excel in engineering as a course of study and as a profession. It is hoped that more educators will use this type of activity to correct the myth amongst girls and young women that a career in engineering is not suited for them. Teachers and academics need to take every opportunity to assure girls and young women that women can contribute as equally as men to engineering, as illustrated by the prominent female engineers featured here. As the world economy becomes increasingly reliant on a technologically literate workforce, the world cannot afford to overlook the talent and potential contributions of half of the population. If it does, societies, nations and our world will suffer.

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APPENDIX 1: Prominent women in engineering and their major achievements.

	Female Engineers	Major Achievements
1	Prathima Agrawal	Computer engineering. She is the Samuel Ginn Distinguished Professor in the Department of Electrical and Computer Engineering at Auburn University. Internationally renowned for her research on computer networks, wireless communication systems, computer-aided design and testing of integrated circuits, and parallel computing architecture and algorithms. Held 51 patents. Elected a fellow of the Institute of Electrical and Electronics Engineers (IEEE) [19].
2	Frances H. Arnold	Chemical engineering. She is the Dick and Barbara Dickinson Professor of Chemical Engineering, Biochemistry and Bioengineering at the California Institute of Technology, where she engineers biological molecules and systems by directed evolution. Held more than 30 patents and has served as science advisor to more than ten companies. Received numerous academic awards, including the 2011 Charles Stark Draper Prize, and is one of the select few who are members of all three membership organisations of the National Academies - the National Academy of Engineering or NAE (2000), the Institute of Medicine (2004), and the National Academy of Sciences (2008) [20].
3	Aine M. Brazil	Civil engineering. She is the Vice-Chairman of Thornton Tomasetti, a 600-person international engineering company. Responsible for the design and construction of high-rise offices, residential buildings, hotels, air-rights projects with long-span transfer systems, hospitals and parking garages. High on the list of accomplishments during her 30+ years of experience is the role she played in leading the structural engineering team for the design of more than three million square feet of high-rise office development in the Times Square area. Has authored numerous technical papers and lectured at universities throughout the US including Cornell, Princeton, and Columbia [21].
4	Ilene J. Busch-Vishniac	Mechanical engineering. She has been the President of the University of Saskatchewan since 2012. She was appointed Provost and Vice-President (Academic) of McMaster University in 2007, and Dean of Engineering of the Johns Hopkins University in 1988. Contributed to research on acoustic noise control, electromechanical sensors and actuators, and engineering education. Held nine patents. Received numerous awards, including the Achievement Award from the Society of Women Engineers in 1997 and the Silver Medal in Engineering Acoustics from the Acoustical Society of America in 2001 [22].
5	Uma Chowdhry	Materials engineering. She has been the Chief Science and Technology Officer Emeritus at DuPont since 2010. She was Senior Vice-President and Chief Science and Technology Officer at DuPont from 2006 to 2010. Contributed to research on advanced ceramic technologies, electronic ceramics, heterogeneous catalysis, high-temperature superconductors, large-scale chemical synthesis, and multi-layer electronic circuit manufacture. Elected a fellow of the American Ceramic Society in 1989, a member of the NAE in 1996, and a fellow of the American Academy of Arts and Sciences in 2003 [23].
6	Maria Q. Feng	Civil engineering. She is a Professor in the Department of Civil and Environmental Engineering at the University of California, Irvine. Contributed to research on the safety and security of civil infrastructure systems, focusing on the science and technology of advanced sensors, structural health monitoring, and damage assessment of civil infrastructure systems. Her research has produced innovative, effective and practical technologies, devices, software and design/analysis methods that are used worldwide to enhance the safety and reliability of civil infrastructure systems. Received, among other awards, the 1995 Alfred Noble Prize and the 1999 Walter L Huber Civil Engineering Research Prize [24].
7	Edith M. Flanigen	Materials engineering. She retired as Senior Corporate Research Fellow from UOP LLC in 1994. Invented a new generation of synthetic molecular sieve zeolites. These are porous crystalline compounds that contain molecule-sized pores that separate molecules on the basis of size. Zeolites are used in the conversion of crude oil to gasoline, water purification and environmental clean-up processes. Held 109 patents. Elected a member of the NAE in 1991. Received the Perkin Medal from the Society of Chemical Industry in 1992. Inducted into the National Inventors Hall of Fame, and received the Lemelson-MIT Lifetime Achievement Award in 2004 [25].

8	Alice P. Gast	Chemical engineering. She has been the President of Lehigh University since 2006. She was appointed Vice-President for Research and Associate Provost at the Massachusetts Institute of Technology in 2001. Contributed to the understanding of the structure and behaviour of complex fluids (especially polymeric and electro-rheological fluids), colloidal aggregation and ordering, protein-lipid interactions, and enzyme reactions at surfaces. Elected a member of the NAE in 2001 and a fellow of the American Academy of Arts and Sciences in 2002 [26].
9	Shirley Ann Jackson	Electrical and electronics engineering. She has been the President of Rensselaer Polytechnic Institute since 1999. Prior to this, she was appointed Chairman of the Nuclear Regulatory Commission in 1995. Recognised for her work on polaronic aspects of electrons in two-dimensional systems. Her research in solid-state physics resulted in rapid improvements in the signal-handling capabilities of semiconductor devices. Spearheaded the formation of the International Nuclear Regulators Association. Elected a member of the NAE in 2001 [27].
10	Kristina M. Johnson	Electrical and electronics engineering. She has been CEO of Enduring Energy LLC since 2010. She was appointed Under Secretary of Energy at the US Department of Energy in 2009, Provost and Senior Vice-President for Academic Affairs at the Johns Hopkins University in 2007, and Dean of Engineering at Duke University in 1999. Recognised for contributions to holography, optical and signal processing, liquid crystal electro-optics, and using a novel variety of liquid crystals to create new types of miniature displays and computer monitors. Held 129 patents. Received, among other awards, the 2008 John Fritz Medal [28].
11	Linda P.B. Katehi	Electrical and electronics engineering. She has been the Chancellor of the University of California at Davis since 2009. She was appointed Provost and Vice-Chancellor for Academic Affairs at the University of Illinois at Urbana-Champaign in 2006, and Dean of Engineering of Purdue University in 2002. Recognised for contributions to three-dimensional integrated circuits and on-wafer packaging. Held 19 patents. Elected a member of the NAE and a fellow of the American Association for the Advancement of Science and the American Academy of Arts and Sciences [29].
12	Julia King	Materials engineering. She has been the Vice-Chancellor of Aston University since 2006. She was appointed Principal of the Engineering Faculty at Imperial College London in 2004, and Chief Executive of the Institute of Physics in 2002. Joined Rolls-Royce plc in 1994 and held a number of senior executive appointments, including Director of Advanced Engineering for the Industrial Power Group and Engineering Director for the Marine Business. Published numerous papers on fatigue and fracture in structural materials and developments in aerospace and marine propulsion technology. Elected a fellow of the Royal Academy of Engineering in 1997 [30].
13	Stephanie L. Kwolek	Chemical engineering. She retired as Research Associate from Dupont in 1986. Contributed to the development and liquid-crystal processing of high-performance aramid fibres. The best known member is Kevlar®, which is five times stronger than steel and used in about 200 applications. Held 17 patents. Inducted into the National Inventors Hall of Fame in 1995. Received the National Medal of Technology in 1996, the Perkin Medal in 1997 and the Lemelson-MIT Lifetime Achievement Award in 1999. Elected a member of the NAE in 2001 [31].
14	Ruby B. Lee	Computer engineering. She was a Professor of Electrical Engineering and Computer Science at Princeton University. Internationally renowned for pioneering multimedia instructions in general-purpose processor architecture, and innovations in the design and implementation of the instruction-set architecture of RISC processors. Held 115 patents. Elected a fellow of Association for Computing Machinery and IEEE [32].
15	Frances S. Ligler	Biomedical engineering. She is the US Navy's Senior Scientist for Biosensors and Biomaterials. Internationally renowned for inventing portable, automated biosensors for detecting pathogens, toxins, pollutants, drugs of abuse, and explosives. Held 33 patents. Elected a member of the NAE in 2005 and a fellow of the American Institute for Medical and Biological Engineers in 2012 [33].
16	Teresa H. Meng	Computer engineering. She is the Reid Weaver Dennis Professor of Electrical Engineering at Stanford University. Internationally renowned for contributions to the system integration of algorithms, parallel architectures and signal processing circuits and for pioneering the development of distributed wireless network technology. Held 15 patents. Founded Atheros Communications Inc, which is a leading developer of semiconductor system solutions for wireless network communication products. Elected a member of the NAE, and a fellow of IEEE [34].
17	Priscilla P. Nelson	Civil engineering. She has been a Professor in the Department of Civil and Environmental Engineering, and the Provost and Senior Vice-President for Academic Affairs of New Jersey Institute of Technology since 2005. Prior to this, she was with the US National Science Foundation, most recently as Senior Advisor to the Director of the

		NSF. Internationally renowned for geological and rock engineering, and the design and construction of underground facilities and tunnels. Played a key role in several major construction projects, such as the Trans-Alaska Pipeline System and the Superconducting Super Collider project in Texas [35].
18	Esther S. Takeuchi	Biomedical engineering. She has been the Greatbatch Professor of Advanced Power Sources at the State University of New York at Buffalo since 2007. Prior to this, she was the Chief Scientist at Greatbatch Inc. Internationally renowned for developing silver/vanadium oxide batteries for implantable cardiac defibrillators and lithium/carbon monofluoride cells for implantable pacemakers. Credited with holding more patents (currently over 140) than any other living woman. Elected a member of the NAE in 2004. Awarded the prestigious National Medal of Technology and Innovation in 2009 and inducted into the National Inventors Hall of Fame in 2011 [36].
19	Bhavani M. Thuraisingham	Computer engineering. She is the Louis A Beecherl Jr Distinguished Professor in the Erik Jonsson School of Engineering and Computer Science and the Director of the Cyber Security Research Center at the University of Texas at Dallas. Internationally renowned for contributions to secure systems involving database systems, distributed systems and the Web. Authored ten books on data management, data mining and data security. Held three patents. Founded two companies, namely Bhavani Security Consulting LLC and Knowledge and Security Analytics LLC. Elected a fellow of the American Association for the Advancement of Science, the British Computer Society and the IEEE [37].
20	Jackie Y.R. Ying	Biomedical engineering. She is a Professor and the Executive Director of the Institute of Bioengineering and Nanotechnology in Singapore, and a Professor in the Department of Chemical Engineering at the Massachusetts Institute of Technology. Internationally renowned for her research on synthesis of nano-structured materials for drug delivery, tissue engineering, bio-sensing, bio-imaging, synthesis of pharmaceuticals, and energy applications. Held 39 patents [38].

APPENDIX 2: Post-activity survey.

1. Who inspired the female engineers to become engineers?

☐ Parents
☐ Peers
☐ Relatives
☐ Teachers
☐ Others. Please specify ______________________________

2. What appointments did the female engineers hold?

☐ Academic staff member
☐ Senior position in engineering industry
☐ Senior position in government
☐ Laboratory assistant
☐ Others. Please specify ______________________________

3. What difficulties did the female engineers encounter at their workplaces?

☐ Absence of female role models, mentors and colleagues
☐ Inadequate physical strength
☐ Male supervisors' stereotyping of women's abilities
☐ Differences in communication style between male supervisors and female engineers
☐ Difficulty in coping with both family and career
☐ Lower pay scales and slower promotion rates for women compared with men
☐ Others. Please specify ______________________________

4. How did the female engineers cope with both work and family life?

☐ Quitting and resuming career some years later
☐ Pro-family workplace policies
☐ Having a supportive and understanding husband
☐ Having an efficient domestic help
☐ Others. Please specify ______________________________