1. Introduction to the *Handbook of Gender and Technology*

_Eileen M. Trauth and Jeria L. Quesenberry_

**INTRODUCTION**

We are so pleased that Edward Elgar Publishers invited us to edit a book on gender and technology entitled *Handbook of Gender and Technology: Environment, Identity, Individual*. The book takes a comprehensive look at societal, organizational, and individual factors that affect gender in relationship to technology use and technology careers. The structure of the book reflects the source of influences on people: the external societal and organizational environments; one’s intersectional identity; and individual factors. Between the two of us we have edited six books on the topics of gender, social inclusion, and research methods, along with several conference proceedings. We have drawn upon those experiences in this book project.

After Eileen completed her PhD in information science, she spent half of her academic career working in business schools and the other half working in information technology (IT) departments. But her abiding interest that remained across various academic appointments has been the human impact of the information society that emerged in the second half of the twentieth century and came to fruition in the early part of the twenty-first. Her particular focus has been the IT workforce. She began by studying the changing skills and knowledge requirements associated with technological change (Niederman et al., 2016). She then moved on to examining the role of IT work in economic development, something that provided opportunities for international research and teaching. Against this backdrop she embarked upon her explorations of the haves and have nots in the information society. Her earliest work consisted of field studies of women in the IT sectors of several countries. This led to development of a theory to explain the IT gender gap, the _individual differences theory of gender and IT_ (IDT Git). Following qualitative studies of women in the IT field in several countries, she broadened her scope and research methods to examine social inclusion issues related to gender minorities based on identity characteristics such as race, ethnicity, disability, and sexuality (Trauth, 2017). In addition to her gender research and publishing, she has also developed and taught gender courses in several countries. Throughout her career, she has looked at gender issues from a variety of vantage points as: an American in other countries, a researcher, a professor, an administrator.

Jeria’s pathway into academia began with a career in IT consulting. Having worked in industry for several years, she had become accustomed to being one of the only women in the office, leading to feelings of isolation and non-belonging. She frequently wondered “where are all the women …?” In 2002, Jeria decided to pursue a PhD in information sciences and technology while working as a research assistant for Eileen. During this time, she began to study career values and motivations of women in the IT workforce. In 2007, Jeria began her faculty career in information systems at Carnegie Mellon University. For the past two decades, her research interests have remained directed at the study of cultural influences on
women in IT, including topics of social inclusion, broadening participation, career values, and organizational interventions. Her efforts have an action-oriented focus including a 15-year longitudinal intervention study of students in computer science at Carnegie Mellon (Frieze and Quesenberry, 2015) and challenging commonly held western views and stereotypes about women in computing (Frieze and Quesenberry, 2020). Throughout her career, she has also looked at gender issues from a variety of vantage points as: an IT professional, a researcher, a professor, and an administrator.2

The purpose of this chapter is to provide some background and context for the chapters that follow. In this first section of the chapter, we discuss our motivation for editing this book. We speak to why we believe it is important to have a book that looks at the issues confronting women and other gender minorities in today’s information-intensive and technological society. We also present a high-level consideration of the issues. In the second section, we discuss the intended audience for this book, its distinctive features, the scope, and the book’s conceptual framing. Then in the third section of the chapter we provide brief overviews of each chapter in this book.

Why Should We Care About the “Gender Problem” in STEM?

We begin with the question of why we should care about the haves and the have nots in the information society. In particular why should we care about a gender gap among those who are constructing this society? Despite the progress made by women and other gender minorities, in breaking down barriers that have held them back, they are still significantly underrepresented in the technology fields.

More than ever before, girls are studying and excelling in post-secondary education. Take for instance, in the United States, women earn approximately 57 percent of all undergraduate bachelor’s degrees. Yet these gains have not been matched in technical areas of study. Only 22 percent of computer and information science undergraduate degree recipients were women. This is a figure down from a high of 37 percent in 1985 (DuBow and Gonzalez, 2020). The gender divide is also evident at the graduate level where in 2019–20 in the United States and Canada (combined), 21.7 percent of all doctoral computing degree recipients were women (Zweben and Bizot, 2020).

This discrepancy persists in the workplace and in some ways is more problematic when considering retention and professional development trends. In the United States, women comprise 57 percent of the professional workforce, but only 26 percent of the IT workforce (DuBow and Gonzalez, 2020). Moreover, this figure is substantially lower than where we were 30 years ago. In 1991, women comprised 36 percent of the IT workforce (Ashcraft et al., 2016), by 2004 the number dropped to only 32 percent (ITAA, 2005), to where we are today at 26 percent. In terms of retention, 56 percent of women left the United States IT workforce within the first five years of employment, which is twice the turnover rate of men in IT and women in other professional fields (Ashcraft et al., 2016; Glass et al., 2013). The numbers show women still hold a small share of IT leadership roles. Women account for only 16 percent of senior level technology jobs, 10 percent of executive positions (Sigacheva, 2018), and 13 percent of chief technology officer (CTO) positions (DuBow and Gonzalez, 2020). Annual salaries for men in science, technology, engineering and mathematics (STEM) are nearly $15,000 higher per year than women ($85,000 compared to $60,828) (Pew Research Center, 2018).
The data is even more alarming when considering the participation of women minorities in the United States IT workforce. Black women comprise around 13 percent of the American population of women but only 3 percent of the IT workforce. Hispanic or Latina women comprise 18 percent of the American population of women but only 7 percent of the IT workforce (DuBow and Gonzalez, 2020; United States Census Bureau, 2020). And Black and Latina women in STEM earn around $33,000 less than men (at an average of around $52,000 a year) (Pew Research Center, 2018). Clearly, women, and in particular minority women, are seriously underrepresented in the United States IT workforce.

When we examine the data from different countries, we find that women are largely underrepresented in IT post-secondary education in many parts of the world. The Organisation for Economic Co-operation and Development (OECD) collects gender-disaggregated data on distribution of tertiary degrees awarded in information communication technology (ICT). In 2015, the average percentage of women for all OECD countries was slightly below 25 percent. In only six countries for which OECD collects data – India (over 40 percent), Mexico, Indonesia, Turkey, Estonia, and Canada – women made up more than 30 percent of graduates in ICT disciplines. India is one of the few notable examples where women comprise 40 percent, 65 percent, and 50 percent of students in computer science and engineering at the undergraduate, master’s and doctorate levels, respectively (Huyer, 2019).

Throughout the world, women are also largely underrepresented in the IT workforce. Chow and Charles (2019) analyzed data from the International Labour Organization and report that (ICT) professional work is the most man-dominated profession in the economically developed regions of Western Europe and North America (16.9 percent women) and Eastern Europe (19.8 percent women). Many countries in these regions have less than 15 percent women’s representation including the Netherlands, Austria, Poland, Germany, Belgium, Switzerland, Hungary, Greece, and the Czech Republic. The figures for Latin American countries and the Caribbean are somewhat better (21.1 percent women). The highest representation of women in ICT work can be found in the Asia-Pacific region (30.4 percent women) and Africa (31.3 percent women).

As the data shows, women are underrepresented across the IT career pathways, from enrollment in secondary and postsecondary programs, to employment in the IT workforce throughout most parts of the world. Yet, data can only tell us part of the story. To get a better understanding of the underrepresentation of women in IT we need to pay immediate and close attention to the factors that might be enabling or deterring women’s participation.

This chapter considers the question of why it is important to address the underrepresentation of women and gender minorities in STEM fields, and why we were motivated to edit this book. A good starting point for the discussion of gender and technology is to address the question of why it is important to change this situation. This question continues to be raised. In 2002, while Eileen was giving a talk at an American university about the IT gender imbalance, a man on the faculty wanted to know why this was a problem. In 2007, during a lecture she was giving in Spain, a man in the audience asked the same question. In 2019, an anonymous reviewer on one of her gender papers asked it again. In 2019, a senior faculty man expressed surprise in a public forum to learn that there were gender issues in IT academia. Jeria has experienced these questions as well. In 2006, while giving a poster presentation at a graduate student symposium, a woman faculty evaluator asked why we should care if women are underrepresented in the technology field. In 2022 (as this book was being developed), during a conference workshop on women in technology the presenters encouraged scholars to be prepared...
“to take on this persistent question” should they choose to study gender and technology issues. As Wajcman (2006) observed, it is “imperative that we examine the extent to which existing societal patterns of gender inequality are transformed or reproduced in a new technological guise” (p. xxii).

To answer this question about why we should care, we begin with a consideration of the global information economy. During the second half of the twentieth century a shift occurred in the nature of work and the basis for economic development. Globally, there began a transition to societies in which information has become a key economic resource. Daniel Bell (1973), who was one of the first individuals to characterize this shift termed it the “post-industrial society.” It has also been characterized as the “information society” or “knowledge society.” Despite the label, the important point is that information and associated technology are significant factors in the economic viability of a society.

In this society the production, manipulation and use of information engages a significant portion of work. Thus, underlying this information society is its “information economy” (Trauth, 2000). The information economy consists of the workers and work engaged in the processing of information and the production of information technology. Porat (1977) characterized the information economy as composed of two parts. The primary information sector is comprised of individuals engaged in work associated with: information and communication hardware, software, processing, and services; and information content. The secondary information sector consists of individuals engaged in some other work (such as health care, transportation or finance) that requires them to process information in order to carry out their work. The combined primary and secondary information sectors have produced a twenty-first century global society in which the production and consumption of information is a significant part.

In the twenty-first century the task of ensuring a supply of qualified IT personnel is increasingly bound up with issues of diversity (Sorensen et al., 2011; Zorn et al., 2007). As the appetite for IT continues to grow, the IT profession is challenged with meeting the demand to enlarge the IT workforce by recruiting and retaining personnel from historically underrepresented groups such as women and other gender minorities. Given the size and importance of the information economy, it is incumbent upon societies to open their doors, completely, to all potential workers. It is a matter of both economic necessity and social justice. So, with respect to the question of why it is important to address the gender imbalance in the IT field, there are several answers (Glover, 2000; Trauth, 2011; Trauth et al., 2006).

The first is that an information economy is characterized as an innovation economy. As technology becomes commodified its production moves to lower wage, typically developing, economies. Consequently, developed nations increasingly focus on continuous innovation related to new information products and services. At the same time, less developed economies look to technological innovation as a key way to move more quickly up the ranks. In such an economy human capital is prized because it is brainpower and creativity that fuels innovation. And the “best brains” are not particular to a certain gender, race, ethnicity or any other identity. Hence, the ability of regions and workplaces to attract and retain diverse talent is growing in importance (Florida, 2002; Trauth et al., 2008a).

The second answer is that in an information society in which virtually everyone is engaged in the consumption of information products, it is crucial that the varying needs of this diverse consumer base be represented. Part of this understanding of diversity needs to be the inclusion of a gender dimension in the development of technology (Trauth, 2019). The air bag story is
now given as a classic example of the failure to include a gender dimension in design considerations. The problem with the automobile air bag is that it was designed with a western man as the generic “person” without sufficient consideration given to the effect of the deployed airbag on someone of a lighter and slighter build than the average western man – with the tragic consequences that have resulted (Smith, 2009). Hence, a diversity of people with different identities and experiences are needed to bring different perspectives to better understand the needs of a diverse consumer base.

The third answer about the need for gender balance comes from demography. In many countries demographic trends add urgency to the need to create a more diverse IT labor force. The retirement of the baby boom generation, coupled with employment shifts following the COVID-19 pandemic, have added stress to a growing IT sector. This IT labor force demand cannot be satisfied by white men alone. Yet, as previously described, the statistics show that women are woefully underrepresented. They make up 26 percent of the United States IT labor force (DuBow and Gonzalez, 2020) and less than 25 percent of the IT labor force of many countries (Chow and Charles, 2019; Panko, 2008). Even more troubling is that this gender gap is not just a function of recruitment into STEM fields, as studies of women’s attrition have revealed (Hewlett et al., 2008; National Academy of Sciences, 2006; Tattersall et al., 2006).

The economic answer to the gender gap question has several dimensions. Recent recessions and the pandemic-induced economic upheavals have driven home the lesson that it is incumbent upon all individuals to be prepared for economic uncertainties. Thus, with the possibility of spouses and partners losing jobs, everyone needs to be prepared to work. As whole industries reshape and sometimes disappear, two-income families are becoming increasingly important. Hence, there is economic vulnerability in a heterosexual household unit that allocates earning capacity based on gender. Given the potential for a husband to become displaced from work, a wife would become the major bread winner. And the economic vulnerability of a household unit with no men in it is even greater. Since women represent half of the labor force of most countries, any society that disenfranchises half of its labor force puts itself at a distinct competitive disadvantage in the competition for brainpower in a knowledge society. Further, there is a productivity dimension. The constant effort to recognize and overcome biases drains one’s time and energy and leads to frequent turnover costs to an organization.

There is also a social equity response to this question. A democratic society espouses fairness to all, providing equal opportunity to achieve wealth. Hence, we need to address societal barriers to women for the same reasons that we do so with regard to race, disability, etc. (Adam, 2005). That is, women need to have the same access as men to jobs that pay well, such as those in the IT field. Also, in today’s information society power derives from control of information and IT. So, women deserve to have equal access to this source of power. Indeed, the recent UNESCO report on artificial intelligence (AI) and gender equality (UNESCO, 2020) adopts a gender equality lens with respect to artificial intelligence. It recognizes that gender biases found in AI training data sets, algorithms and devices have the potential of spreading and reinforcing harmful gender stereotypes. Further, the growing ubiquity of AI puts women at risk of being left behind in all realms of economic, political, and social life, since the majority of workers holding jobs that face a high risk of automation, such as clerical, administrative, bookkeeping, and cashier positions are women.

Finally, there is a policy answer. Addressing the gender imbalance in IT is part of a global gender equity movement at both the national and organizational levels. For example, the European Union (EU) requires the inclusion of “gender mainstreaming” – integrating a gender
equality perspective – at all stages and levels of policies, programs, and projects. Some countries have instituted gender quotas, such as Germany’s 2016 law requiring that 30 percent of executive and supervisory positions be held by women. Other countries, while not bound by law, have established aspirational policies represented by membership in the “30 Percent Club.” Awareness about gender and technology is steadily moving from the periphery to the core of concerns in the field.

How Should We Think About the “Gender Problem” in STEM?

Notwithstanding those who continue to question the technology gender gap, growing numbers of organizations and individuals have expressed a desire to address this imbalance. They seem to care but don’t always know what to do, demonstrating a need to both understand and frame the “gender problem.” The earliest research on the gender gap in the STEM disciplines was conceptualized as “gender differences” research, employing quantitative data to focus on whether and where gender differences existed with respect to the use of technology – sometimes characterized as a “digital divide” (Cooper and Weaver, 2003) – and participation in its careers. The focus of this research was on providing evidence of a gender gap but not on understanding the reasons for it. But what is needed now (whether using quantitative or qualitative methods), is to get at the story behind the statistics in order to explore why these differences exist and how they came about. A concerted effort is needed to both understand and address gender barriers affecting engagement with STEM fields. This is achieved by taking a critical look at what it is that needs to be fixed, which will shed light on who or what is broken.

A common explanation that has been given for the gender imbalance is that women are not cut out for technical work. This explanation assumes a universal gender binary and suggests that the world of work can be dichotomized into fixed masculine and feminine domains. Hence, there are types of work that are natural to each of these two genders, with STEM being “natural” to men only. But critiques of the gendered nature of STEM disciplines from a feminist perspective have, for decades, taken on prevailing societal assumptions about STEM being an exclusively masculine domain (e.g., Harding, 1986; Schiebinger, 1999).

This stereotype about gender-technology relations is that women are soft, nurturing, and ill-suited to technological pursuits. They are too emotional, irrational, and illogical to excel in STEM fields. Men, on the other hand, have an inherent fascination with machinery enabling them to excel in STEM fields. Societal stereotypes about hegemonic masculinity, the culturally dominant form of masculinity that include traits such as virility, exploitation, dominance, and aggressiveness, further reinforce this stereotype (Connell, 2005; Wajcman, 1998).

The association of this hegemonic masculinity with technology derives from a similarly stereotypical and narrow view of STEM, leading to damaging stereotypes about technology careers. Stereotypical views of STEM suggest that to work in these fields is to disdain interacting with other people. Fields such as IT are stereotyped as solitary, its work done by individuals with little or no interest in group interactions. Those who enter such professions are assumed to be antisocial workaholics lacking in social skills. This reflects a tendency to think of “technology” as simply an artifact. A broader view is that technology is the embodiment of those who invent, develop, and use it.

As we have seen repeatedly, technology is more than a set of physical objects or artifacts. It also fundamentally embodies a culture or set of social relations made up of certain sorts of knowledge,
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beliefs, desires and practices … Treating technology as a culture has enabled us to see the way in which technology is expressive of masculinity and how, in turn, men characteristically view themselves in relation to these machines. (Wajcman 1991, 149)

The inclusion of gender biases, assumptions, and stereotypes in the conceptualization of technology can be a negative influence on women’s participation in STEM. For example, the perception that technology work must necessarily be all consuming in one’s life can be a deterrent to those women who expect to assume primary or full responsibility for children and the domestic realm.

People often use observations about the STEM gender gap as the explanation for it. But this explanation doesn’t stand up to the facts. If women are not suited to technical work, then how could there be any women in technical fields? Further, if we look at different points in history, we will see that there is no consistency in women’s participation in technical work. Programming was originally a feminine pursuit, as evidenced in recent visibility of the “ENIAC girls” — women who programmed the first general purpose electronic digital computer in 1946. Further, during World War II women took on the majority of manufacturing jobs while men were in military service.

Other explanations suggest that the gender gap is due to the fact that women – and other gender minorities – are somehow “broken.” Hence, while they might have the potential to work in STEM, the reasoning goes, they must first undergo technical remediation in order to be capable of technological careers. Such an explanation reproduces stereotypes of those who are underrepresented in STEM as technologically ignorant. Accompanying this explanation is the view that things are changing, the gender gap will disappear; it just takes time. However, this “fix the women and wait” explanation also does not stand up to the data. The gender gap has not been significantly reduced during the time that such explanations have been put forth. Hence, in the absence of some fundamental interventions, the gender gap will continue.

This book is motivated by an interest in alternative explanations that are not grounded in misogyny and gender stereotypes. We wanted to look beneath the surface of superficial explanations in order to examine deeper causes for the gender imbalance, rejecting the simple assumption that lack of representation means lack of interest. We wanted to question the unstated link between hegemonic masculinity and technology. Accounting for the gender-technology gap in this way directs us to situate gender-technology issues within the larger landscape of diversity and inclusion. We wanted to examine the social shaping of women and gender minorities with respect to technology: cultural messages about who “fits” into a particular role, which often result in people imposing limits on themselves regarding what they can do in life (Lerman et al., 2003; Wyer et al., 2001).

This social shaping takes various forms. Women and gender minorities can be the target of biases – beliefs, attitudes, norms, and stereotypes – visited upon them by agents – individuals and organizations in the larger society. These biases can be consciously held beliefs about the role of gender in society, in STEM, or about gender-based intellectual capacity to work in STEM fields. Or they might be unconsciously held beliefs such as that women should be nurturers, that leadership is not feminine, or that women are less committed in the workplace: they have jobs, men have careers. These attitudes present underrepresented people with subtle barriers that can hold them back. Valian (1999) refers to these as “gender schemas.” Sometimes explicit barriers are imposed through discriminatory behaviors. This might be gender-differentiated advising or treatment in a classroom, being left out of after-work
socializing, or having one’s contributions overlooked. While these behaviors can be either intentional or unintentional, they nevertheless serve as a barrier to women and gender minorities. Sometimes these beliefs and stereotypes are unconsciously *internalized*, so that what might appear as a girl not being interested in STEM, is really her succumbing to a negative gender-technology discourse.

To understand and rectify the issues underlying the gender gap in STEM we need to develop a better understanding of socio-cultural factors that serve as barriers to and facilitators of the recruitment and retention of women and gender minorities. This, in turn, will aid comprehension of why some individuals are able to overcome barriers while others cannot. Hence, this book includes chapters on theoretical developments to enhance our understanding of the gender imbalance as well as consideration of interventions that flow from research. The research presented in this book speaks to gender equality as it applies to recruitment and retention into technology fields. Chapters also highlight intervention projects to raise awareness about gender diversity, promote understanding about gender dynamics, and question assumptions about gender, masculinity, femininity, and STEM.

The Intervention Problem

If we adopt the perspective that what is “broken” is society and its organizations, not those who are underrepresented, then we must look to both educational institutions and the workplace to address the situation (e.g., AAUW, 2000). In furtherance of these needs, this book presents research with the ultimate goal of using it to inform interventions that will make a positive contribution to addressing the gender imbalance. This perspective also suggests that interventions need to affect both recruitment into and retention within STEM careers.

Several approaches to interventions have been taken. One is to use quotas to increase the representation of women. This is the case in EU countries that are striving to have a critical mass of women in managerial positions. However, having quotas alone can be a problematic intervention. It could be misinterpreted as hiring unqualified women and gender minorities just to satisfy a quota, which could lead to tokenism. Further, having a few high-profile women in technology roles does not mean that it is “normal” for any woman to work with technology. Adding more women, alone, does not address the issue of why there are so few women to begin with. Interventions also need to go deeper, to be tailored to specific issues encountered by specific individuals in specific contexts. Another approach has been to base interventions on an intuitive sense of both what “the gender problem” is that needs remediation, and the best way to address it. But the risk is that the interventions are not addressing the actual problems. For example, women who are facing sexual harassment in the workplace will probably not be helped by maternity leave policies.

What we need, instead, is a clear understanding of intervention need that is based on data and theoretical insights in order to frame “the problem,” and to use this insight in the development, ongoing implementation, and assessment of interventions (e.g., Adya and Kaiser, 2005; Annabi and Lebovitz, 2018; Blickenstaff, 2005; Clayton et al., 2021; Craig, 2016; Gorbacheva, 2019; Klawe et al., 2009; Panteli, 2012; Quesenberry and Trauth, 2012; Ridley and Young, 2012; Trauth, 2010). A significant amount of time, money and effort is being spent on activities to address the gender imbalance in the technical workplace. Yet, the gender imbalance persists. This suggests that in addition to a “gender problem” there is also an “intervention problem.” But why does it persist? We believe there is a disconnect between gender
scholarship and the efforts of well-intended people who develop interventions. We argue for more “evidenced-based interventions.”

For example, consider the different explanations for the underrepresentation of women and gender minorities that have been considered thus far in this chapter. One is that they do not have the ability and skills to be successful in a technical career. A second is that they are uninterested in technical careers. A third is that members of these gender groups perceive technical careers as outside the scope of someone with their particular identity. But a fourth reason is that they have career opportunities elsewhere that they perceive to be more rewarding in terms of status, salary, job security, etc. Finally, their families may not want them to pursue technical careers for some reason. So, before undertaking interventions for a particular group of underrepresented individuals, research is needed to determine which causes to address.

One size does not fit all. For example, motherhood accommodations are a good thing for those who have children but wouldn’t address other issues encountered by women. And the diversity climate in an educational institution for straight, white women might be perceived as very good, while LGBTQ students might experience the climate very differently, and negatively. What this means is that in the absence of data, a generic approach to diversity, equity and inclusion interventions might not address the real problems at hand.

Interventions need to be implemented at all levels: societal, institutional, organizational. They need to be implemented by policy makers, parents, educators, and employers. UNESCO (2020) offers an example of societal-level interventions in the form of proposed elements of a gender equality framework related to artificial intelligence. So that women are not left behind, it argues for a whole societal-level view of issues, positioning gender equality as part of AI ethics principles. It also offers possible approaches for operationalizing AI and gender equality principles. The EU project, Female Empowerment in Science and Technology Academia (FESTA) is a good example of institutional interventions, in this case in research universities and institutes (Salminen-Karlsson, 2016). In the United States the AAUW has produced two important documents that put forth interventions to address the gender gap in STEM (Hill and Corbett, 2010; Corbett and Hill, 2015). An example of organizational interventions can be seen in the efforts of Carnegie Mellon University to attract and retain women students in STEM (e.g., Frieze and Quesenberry, 2020; 2019; 2015; Margolis and Fisher, 2002). The percentage of women enrolling and graduating in undergraduate computer science and information systems at Carnegie Mellon has consistently been near or above 50 percent. In a nutshell this was achieved by changing the culture in four critical areas: (1) building institutional support (deans, faculty, staff, administrators, funding, and values); (2) revising admissions criteria while maintaining an academically challenging curriculum; (3) offering student leadership opportunities through creative women’s organizations (providing leadership, mentoring, encouragement, and peer-to-peer programs); and (4) leveling the playing field (to ensure women, and others, do not miss out on valuable social, academic, and professional opportunities and experiences).

One purpose of this book is to examine the tension between the general and the specific. The chapters in this book demonstrate the way in which gender barriers (and the dismantling of them) result from a combination of societal influences, structural barriers, and varied individual responses to them. They also address the interaction between research and intervention by considering one or more of the following goals: raising awareness about stereotypes, biases, and barriers; changing attitudes about who can participate in STEM careers; and motivating behavioral change to dismantle stereotypes and other barriers.
BACKGROUND

Audience

The goal of this book is to offer a single source to those interested in knowing more about the topic of gender and technology, and about state-of-the-art research and interventions. The intended audience for this book consists of people who want to delve more deeply into the nuances of gender diversity in the technology fields. Collectively, this book represents many years of research, lecturing and teaching about gender and STEM by the contributing authors. The chapters in this book provide the reader with access to theory and results of research on the topic of gender and technology written by some of the best minds globally. While the contributing authors have written a considerable number of academic research papers, a wider audience is intended for this book. We wanted to edit a book that could be understood by general readers without specialized knowledge of science and technology or gender studies, but who are interested in knowing more about the gender imbalance in the STEM fields, and what can be done about it. Great care was taken with the language and writing of the chapters to ensure that the information contained in them would be accessible to both academic and non-scholarly readers.

Hence, this book can support general awareness as well as research, teaching, and interventions. It can help people who want to better understand the diversity of colleagues with whom they are working. This might be managers who want to understand how to go about addressing gender issues in their companies, or who are charged with implementing gender mainstreaming policies. It can also support gender studies academics looking at the STEM context, or technology professors and graduate students interested in conducting gender research.

This book can also support teaching. Both of us have taught courses that this book could have supported were it available. Eileen has developed and taught a number of courses (both in the United States and in several other countries) in which gender was the sole focus or was part of a larger focus on diversity. Similarly, Jeria has included gender as topics in her social issues teaching and in several undergraduate research projects. This experience with course development and teaching has influenced our approach to editing this book and the structure into which the chapters are arranged: environmental, identity, and individual influences on gender.

Finally, this book can be helpful to organizations that are interested in developing interventions to redress the gender imbalance. This is because the interventions considered in these chapters are informed by research and not gender stereotypes. Often, we hear about failed interventions – perhaps well intentioned – that were not found to be effective or well executed. The ongoing gender gap in IT coupled with these issues have prompted a call for action from the academic community for theoretically grounded research that can inform more effective interventions through data-driven practices (e.g., Annabi and Lebovitz, 2018; Trauth, 2013; von Hellens et al., 2012).

Distinctive Features

We were motivated to take on this book project out of our commitment to advancing gender equity in the technology fields. We see this book as a foundational source for anyone interested in gender and social inclusion in STEM and IT, whether a new or an established scholar, who wants to undertake gender research. The number of requests we have received from scholars...
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asking for advice about identifying relevant literature, and the number of journal special issues
on gender and social inclusion² are indicative of this need. This book is also an essential source
for those interested in teaching a course on gender, social inclusion, or adding these topics
to an existing course. This is the readable book we wish had existed when we undertook our
gender research and teaching!

This book has several distinctive features. First, there are many authors but unlike papers in
special issues of journals this book has a conceptual unity. This is because chapters are organ-
ized according to three themes representing constructs of a theory that both editors have used
in research: environment, identity, individual. Each chapter is connected to one of these three
themes. Second, while there is thematic unity, the approaches taken by the authors vary. They
include a variety of qualitative and quantitative methods. Some are positivist, testing models
and hypotheses. Others are interpretive, seeking to understand the subjective reality of those
who are experiencing gender and STEM barriers. Still other authors take a critical approach,
looking at wider systems of oppression to challenge existing assumptions about gender and
technology, asking whose interests are being privileged by the existing power structure
(Howcroft and Trauth, 2008). Third, the book has representational unity. Despite the wide
variation in topics and approaches, each chapter has the same format so as to make it easier
for readers to understand: Introduction (which includes the purpose and chapter roadmap);
Background (what is necessary about theory, prior literature, etc. for the reader to understand
the chapter); Main part of chapter; Conclusion (stating chapter contribution). Fourth, the
writing style is welcoming to a wide variety of readers. The chapters employ storytelling and
reflexive modes, not typically found in scientific research reporting (Trauth, 2011). Some
authors also employ a memoir format in which they reflect on their body of gender research.
The tone of chapters is honest, straightforward and transparent, emphasizing accessibility of
content to non-experts, and a global audience.

As a whole, this book takes a comprehensive look at societal, organizational, and individual
factors that are affecting the relationship between gender and technology. The structure of
the book reflects the source of influences on people: the external societal and organizational
environments; one’s intersectional identity; and individual influences. Each of the three parts
is focused on one of these sources of influence. Chapters focus on specific factors that can
explain/predict the enhancement or inhibition of underrepresented groups’ engagement with
STEM and information technology. Collectively, the chapters raise issues, discuss findings,
and introduce interventions.

Scope

We are both scholars in the information technology field, hence our perspective on “technol-
ogy” and STEM is very much oriented in that direction, and most of the chapters have that
perspective on technology. For this reason, readers will notice that we have used the terms
“information technology” and “STEM” almost interchangeably in this chapter. However,
we believe findings about gender and IT would arguably apply more broadly to STEM. Neverthe-
less, there is a need for more work that looks at gender and technology from other
STEM disciplinary perspectives.

Therefore, the focus of chapters in this book ranges from STEM, broadly understood, to
information technology in particular. They look at both developers and users of technology.
The book takes a broad view of gender that includes not just women but also gender minorities
based on intersection with identities such as race, ethnicity, nationality, sexual orientation, and disability. It is also broad in geographical scope. Authors from around the world were recruited to ensure that the resulting book would offer a global perspective on these topics.

The issues addressed in these chapters speak to both recruitment and retention of women and gender minorities in STEM. Recruitment focuses primarily on educational and environmental factors in one’s educational development that enhance or inhibit subsequent entrance into the STEM professions. Retention, on the other hand, focuses primarily on workplace factors that enhance or inhibit progression up the career ladder as well as job turnover behavior and intent. While some chapters report on research so that the reader can better understand the issues, others focus on interventions intended to address them.

Conceptual Framing

We chose the factors represented in the individual differences theory of gender and information technology as the conceptual framework for organizing the chapters in this book. We did so because this theory takes into account factors along the continuum from societal to individual, consistent with calls for multiple approaches to and perspectives on women, gender and technology from different levels of analysis: culture and societies, institutions, organizations, and individuals (Fox et al., 2006). Hence, the chapters seek the answer to the gender gap by examining societal factors, structural barriers and varied individual responses to them. In doing so, they address factors at both individual and group levels of analysis. This is not to say that all of the chapters in this book use IDTGIT as the theory guiding the research. Rather, the themes explored in each of the chapters touch on aspects of IDTGIT.

Environmental influences are contextual factors in society, institutions, and organizations, which affect the interaction of women/gender minorities and technology. These include cultural, economic, infrastructural, and policy influences that can facilitate or discourage interest in a technical career. These influences include both societal-level (e.g., Trauth et al., 2008b) and organization-level (e.g., Quesenberry and Trauth, 2012) influences. Individual variation in the effect of these environmental influences occurs in two ways. Individual identity refers to demographic characteristics such as ethnicity, age, socio-economic class, and motherhood status, which result in different gender discourses and biases affecting an individual. It also includes IT identity, which considers the effects of working in different aspects of the IT field. Individual influences incorporate the effect of significant people and experiences along with personal characteristics, on women, girls, and other gender minorities. That is, significant people in one’s life (role models, mentors, sponsors) are conduits for the transmission of both societal barriers and ways to resist them. Hence, individual influences serve to either inhibit or enhance barriers to participation in STEM fields. Within gender-group variation occurs because the group-level influence of environmental factors (e.g., in a particular culture) can be either reinforced or mitigated by one’s identity and individual influences.10

CHAPTER SUMMARIES

One of the most interesting and rewarding aspects of preparing this book was the collaboration with our authors who brought their diverse perspectives to the work. We are delighted to include 21 chapters from 34 experts, practitioners, researchers, educators, and activists who
are leaders in understanding gender and technology. The authors raise interesting questions and use a variety of approaches and methods to present their findings. The authors also represent a variety of different disciplines – such as computer science, data science, information sciences, management information systems, communications, gender studies, political science, and public administration – which lends richness to this work and its conclusions. Each chapter was reviewed by at least one other author in addition to the two editors.

The book begins with a chapter by Eileen Trauth, which provides an overview of the IDTGIT and how it was born out of a desire to balance the role of societal and individual factors in explaining the underrepresentation of women in the IT field. As described earlier, the theory’s premise is that women are not a monolithic group, all experiencing the same biases and barriers in the same ways, and therefore requiring uniform interventions. Rather, the gender gap results from environmental influences that are moderated or enhanced by one’s intersectional identity, and individual factors. Her chapter demonstrates how the reasons for this disparity are to be found in the interaction of societal influences and individual variation in response to them. She also describes how the theory can be applied to social inclusion more generally and extended by the addition of a dynamic dimension, which explains the ways in which these factors exert their influence over time and context.

The following chapters are then organized into three parts according to their focus on one of the three constructs of the IDTGIT: environmental influences, identity influences, or individual influences.

Part I: Environmental Influences

Environmental influences refer to societal, institutional, and organizational factors that are external to the individual and generally beyond one’s control. Culture can be considered a pattern of shared group assumptions that is broadly shaped by the environment. Cultural definitions of femininity that place IT outside the boundary of “feminine” may depict the technological profession as non-feminine. This part of the book explores the cultural, economic, infrastructural, and policy influences that can facilitate or discourage interest in a STEM career.

The first two chapters in the environmental influences part focus on societal-level perspectives. Patience Akpan-Obong shows how policies in many African countries often frame the role of women in the development process as an afterthought leading to problematic consequences. Drawing from secondary research and personal interviews with women in Nigeria and Cameroon, her chapter traces the evolution of women’s interactions with technologies from the nascent stage as users of basic information communication technologies to the forefront as entrepreneurs and developers. Her work showcases innovative practices by women in gendered systems of exclusion and frames African women as agents of development. Gyeung-min Kim, Namjae Cho, and Hee-Sun Kim employ a contextual hierarchy perspective to investigate how the IS service industry’s project-based work practice influences the work lives and career development of women professionals in Korea. Their work uses a thematic interview analysis of women employees in large IS service firms in Korea conducted in 2010 and again in 2021. The findings show that very little change occurred and that masculine discourses originally found in the IS service industry are continuously repeated and reproduced a decade later. Although these two regional contexts are quite different, their work
demonstrates how environmental influences shape gender norms and expectations for women in technology careers.

There is a need to consider environmental factors such as national culture and policy when seeking to progress women’s workforce participation and advancement in STEM. The environmental influences part of the book explores several projects funded by the European Union that aimed to improve gender equality policies at the organizational, country, and multinational levels. Minna Salminen-Karlsson provides an analysis of a five-year Female Empowerment in Science and Technology Academia (FESTA) project which aimed to advance gender equality in STEM departments in seven European countries. The focus of the project was primarily on improving the working environment of junior researchers. The FESTA actions centered on collecting and presenting relevant metrics, improving PhD supervision, enhancing informal decision making and communication, and managing resistance. Regina Connolly and Ita Richardson describe why environmental scaffolding must be accompanied by micro-level organizational initiatives that focus on systematically embedding gender equality. Their chapter focuses on one such initiative, Athena SWAN, which supports the systematic embedding of gender equality best practices in third-level educational institutions and supersedes previous episodic initiatives undertaken in pockets around universities and led by individuals. Drawing on the perspective of the University of Limerick, their chapter details the benefits and contribution of Athena SWAN to supporting women’s career progression, presenting relevant data from STEM, and outlining associated challenges. Elena Gorbacheva and Isabel Ramos provide an analysis of the accomplishments and the challenges encountered by the Departments of Information Systems at the University of Muenster in Germany and the University of Minho in Portugal during the EQUAL-IST project entitled “Gender Equality Plans for Information Sciences and Technology Research Institutions.” The project worked to implement structural interventions that changed organizational rules, regulations, processes, and cultures to enhance gender equality, diversity, and work–family balance at the participating research institutions. These chapters provide detailed summaries of interventions at the environmental level that have brought positive impacts to academia, while identifying areas for continued efforts.

The environmental influences part also focuses on how organizational climate is rooted in values, beliefs and assumptions, and demonstrates some of the ways women navigate and respond to these influences. Monica Adya and Sangeeta Parashar discuss socio-cultural and contextual nuances contributing to different patterns of entrenchment and participation of immigrant Indian- and native-born women in the IT workforce in the US. They found that women born in India demonstrate a functional engagement with STEM careers due to socio-economic and cultural benefits, but those dissatisfied with such careers could feel entrapped due to the same factors. In contrast, native-born women indicate greater career fluidity which, while impacting their long-term participation in IT careers, may lead to greater labor force participation overall. Cynthia K. Riemenschnieder and Deborah J. Armstrong address the ups and downs of being a woman academic studying and living out gender within the IT field within the United States. They reflect on their careers in terms of publishing, leadership, and service by looking at issues faced and suggestions for others from the lessons they learned. Their reflexive analysis stresses the importance of intentionality, perseverance, and community. These two chapters show how societal and organizational expectations and policies can improve pathways for women in technology, yet their careers can often hit environmental obstacles and challenges as they attempt to persist and advance.
Part II: Identity Influences

The effect of environmental influences can be varied among the individual identity constructs. Individual identity refers to demographic characteristics (such as ethnicity, age, sexual orientation, disability, socio-economic class, motherhood status, etc.) and how these intersect with gender identity. This part of the book explores how identity influences can facilitate or discourage interest in an IT career.

In the first chapter of this part, Eileen Trauth explores life history interviews conducted with women IT professionals in the United States to illustrate how a woman’s intersectional identity interacts with societal and individual influences to enhance or inhibit her participation in the IT sector. More specifically, she applies a framework developed in Trauth and Quesenberry (2006) to explain how a woman’s intersectional identity influences her exposure to, experience of, and response to gender biases and barriers. The chapter considers three identities: motherhood, race/ethnicity, and sexual orientation, and demonstrates how an understanding of intersectional identity is crucial to advancing our knowledge about gender barriers and how they affect women in the IT field.

The identity influences part continues with two chapters that consider intersectionality of ethnicity, race, and gender. Lynette Yarger, Courtney Smith, and Adanna Nedd examine the relationships between diversity, equity, and inclusion in the technology workforce and the building of artificial intelligence (AI) hiring systems that discriminate. They discuss two threads of argumentation. The first uses Hill Collins’ Four Domains of Power as an organizing framework for presenting factors that contribute to the underrepresentation of women, Black, and Latinx workers in the American technology industry. The second thread discusses how underrepresentation in the IT workforce perpetuates biases in the building and impacts of AI hiring systems. Curtis C. Cain describes BLKGENIUS, which is both a research project to understand the dynamic experiences of Black men in IT against a societal backdrop of barriers that inhibit participation, and an intervention mechanism to highlight successes. His chapter provides a background on the history of Blacks in the United States, Black men in IT, post-secondary education, and the IT workforce. BLKGENIUS stands to make a tangible, positive impact on Black men by providing them the ability to interact with mentors who may share similar lived experiences.

The intersectionality of gender and several other identities is also explored in this part of the book. Eric Patridge uses a retrospective lens to highlight cultural factors affecting lesbian, gay, bisexual, transgender, queer, and allied (LGBTQA+) communities, focusing on a community-based intervention that advances such individuals in the STEM disciplines. He describes how a non-profit organization, oSTEM (Out in STEM), was created to help advance LGBTQA+ people in STEM. The oSTEM leadership has cultivated a community of skilled and diverse people, building bridges across identities while celebrating differences. The community includes both students and professionals from the United States, Canada, the United Kingdom, and beyond. Eleanor T. Loiacono and Shiya Cao explore the intersectionality of gender and disability relevant to IT accommodations and employment. They investigate individuals’ experiences and differences in receiving IT accommodations as an organizational diversity intervention that helps employees with disabilities integrate into the workplace. Their work provides the reader with a better understanding of individual differences in the accommodation process, and how to empower women with disabilities in the workplace. Manju K. Ahuja reflects on her career journey and the context and circumstances surrounding the
genesis of her conceptual paper on gender in IT (Ahuja, 2002) and the research it generated. She focuses in detail on the research related to motherhood and the specific issue of work–life balance (WLB) and its relationship to career persistence and advancement of women in IT. She concludes with a discussion of the caregiving crisis as the pandemic gave rise to the Work from Home phenomenon, transforming the nature of work, and how it has affected women’s employment status. The chapters in the identity influences part of the book show how the interconnected nature of social categorizations (such as gender, race, sexual orientation, disability, etc.) can create overlapping and interdependent systems of opportunities and challenges to participation in technology fields.

**Part III: Individual Influences**

Individual influences refer to the role of significant people (such as parents, teachers, role models/mentors, social networks) and life and work interventions in one’s interest in a technical career. Individual influences can also involve personal characteristics (such as personal agency, self-efficacy, and empowerment). Personal influences and experiences often help to mitigate negative societal influences. Personal characteristics motivate entry into technical careers and retention within them by utilizing resistance and coping methods. This part of the book explores the ways that individual influences can facilitate or discourage interest in an IT career.

Many interventions that focus on individual influences are frequently aimed at young girls and recruitment pathways. Two chapters in the book provide in-depth examples of such interventions. Tricia Massey, Jenine Beekhuyzen, and Sue Nielsen describe the Tech Girls Movement Foundation, which champions Australian schoolgirls using hands-on learning to transform their futures and encourage equity in the technology industry. They offer an overview of the origins of Techgirls and highlight some of the integral work being done to expand girls’ opportunities to engage with STEM. Their work demonstrates how role modeling and mentorship in multifaceted realms are central to notions of identity construction. Moreover, in her chapter, Roli Varma focuses on organizational efforts to increase the proportion and experiences of women in IT education and employment. She comments on the work of the National Center for Women in Information Technology (NCWIT) from her perspective as a gender scholar, a Social Science Advisory Board member, and one who focuses on areas of particular importance for women of color. The examples provide empirical evidence that intentional interventions can have a positive influence on individuals, yet these approaches should be data-driven and managed in order to maintain sustainable success.

Retention interventions are critical components of individual influences. As such, two chapters explore novel organizational approaches. Hala Annabi reviews limitations inherent in IT interventions aimed at retaining women due to their grounding in essentialist views of women and ignorance of individual differences. She draws on ten years of research to detail how women use individual coping methods to address barriers in the workplace and the impact they experience having to devise and practice these methods. Mari W. Buche introduces an innovative technique called job crafting to help develop and retain diversity in the IT workforce. Job crafting is an approach used to help employees modify their jobs to improve overall work engagement rather than focusing exclusively on the negative aspects of workplace challenges and frustrations. With this intervention, women IT professionals can assess their
tasks, professional relationships, and cognitive impressions, identifying ways to improve their experiences in the workplace.

The individual influences part also focuses on personal characteristics. Florence M. Chee, Todd Suomela, Bettina Berendt, and Geoffrey Martin Rockwell examine ethical issues that emerge when conducting research projects that rely on data scraped from online sources (e.g., social media sites, blogs, and forums). Their work focuses on online harassment and hostility, and in particular, the case of Gamergate. Gamergate was an online harassment campaign that promoted sexism and anti-progressivism in video game culture. Their chapter explores two ethical questions: (1) should social media authors be considered research subjects; and (2) how Ethics of Care can support researchers in their exposure to toxic material. Jeria Quesenberry draws from a 15-year longitudinal study of computer science students at Carnegie Mellon University to show how personal efficacy was a driving motivator for women to pursue a technical degree. Interviews with students show that individual characteristics were often the most important factors influencing decisions. Yet there was a growth in the importance women placed on self-efficacy in their decision making. K.D. Joshi picks up this thread by critically examining the role of technical and nontechnical IT self-efficacy in narrowing the IT gender gap. She illustrates how the key sources of self-efficacy that are essential for building confidence are working against women. She concludes with a call to action – if we want to reverse this trend, it is necessary to examine the role of those who are engaged in exclusion.

CONCLUSION

Earlier we posed a somewhat rhetorical question, why should we care about the “gender problem” in STEM? As we explained, there are many economic, equity, and moral answers to this question. Perhaps the more challenging question to answer is how do we address the “gender problem” in STEM? Despite many years of research, interventions, and funding, we still have yet to solve the problem. Thus, if we are serious about increasing the number of women in technological fields then all of the stakeholders – men, women, scholars, educators, managers, and policy makers – must be part of the solution. But in order to do this we need to share our knowledge about the barriers and best practices for reducing them (Trauth, 2010).

Our intention in this introduction is to set the stage for the chapters that follow in this book, which problematize the important questions and offer informed approaches and solutions. K.D. Joshi (Chapter 22) sums up our motivation for editing this book:

The accelerating pace with which technology is influencing our work and lives means that the future will be shaped and controlled by people who know how to design and build technology. To ensure that the future of work and life is not decided for women in advance, women need to actively participate in designing and building future systems, algorithms, and technologies.

To address the gender gap in STEM we need to develop a better understanding of socio-cultural factors that serve as barriers to and facilitators of the recruitment and retention of women and other gender minorities in the STEM field. We intend for this book to further our understanding of the influences on people: the external societal and organizational environments; one’s intersectional identity; and individual factors that help determine and increase broader participation.
The work ahead promises to be both challenging and necessary. As Hala Annabi (Chapter 18) so critically points out:

Interventions must be aimed at addressing the barriers women experience rather than trying to fix the women to assimilate to the IT culture. Making the women assimilate is not only immoral, but it also defeats the purpose of bringing a diversity of perspectives to the workplace.

Our authors highlight intervention projects to raise awareness about gender diversity, promote understanding about gender dynamics, and question assumptions about gender, masculinity, femininity, and STEM. In doing so, this collection furthers theoretical developments to enhance our understanding of the gender imbalance. It also presents interventions that flow from research to empower women, and promote meaningful diversity, equity, and inclusion efforts in STEM.

NOTES

1. For a period of time, Eileen served as an Associate Dean for Diversity, Outreach and International Engagement.
2. Jeria currently serves as the Associate Dean of Faculty in the Dietrich College of Humanities and Social Sciences.
3. See Trauth (1999) for the example of Ireland, a country that grew its economy relatively quickly, in large part, through IT and innovation.
5. For earlier work on recruitment and retention interventions see Burger et al. (2007); Cohoon and Aspray (2006); and Trajkovski (2006).
7. Lesbian, gay, bisexual, transgender or queer.
8. For more discussion of these courses see Trauth et al. (2007); and Trauth and Booth (2014).
10. See Chapter 2, and Trauth and Connolly (2021) for a more detailed explanation of this theory.

REFERENCES

Introduction


