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Gender mainstreaming. “Fixing” the gender divides in ICT programs within universities

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ABSTRACT

Although information and communication technology (ICT) is a fast-growing sector, transforms societies radically, offers many job and career growth opportunities, and is higher paid, women are highly underrepresented in ICT-related programs. This study asks the following research questions: What is the rate of women’s participation in different kinds of university ICT programs? How can women’s participation in IT programs be improved at the university level? For addressing these questions, the chapter presents two cases, namely, Universidad Nacional, Costa Rica and Aalborg University, Denmark. Although both Costa Rica and Denmark occupy privileged positions in the Global Gender Gap Index, they also face challenges. Based on a thorough analysis of national and detailed ICT program data from the cases, the chapter concludes that, to overcome the gender divide, radical and complex “fixing” of the organizations and ICT programs is needed. Instead of “fixing” the women, a requirement that builds on a deficit model of women, the data support a mainstreaming strategy to ground the ICT programs in a humanistic orientation and promote diversity among staff, especially at the full professor level.

INTRODUCTION

As the world moves toward an increasingly digital economy, many countries face the lack of a sufficient number of qualified people to fill jobs in areas related to information and communication technology (ICT) (Nager & Atkinson, 2016), a situation that is intensified by the low representation of women in these industries. Increasing women’s participation in the ICT-related workforce would help close this gap; however, the proportion of women graduating in IT-related careers is declining in many parts of the world (Ashcraft, McLain, & Eger, 2016; Powell & Chang, 2016). Despite continuous progress, today, the world still has a long way to go toward gender equality, and women continue to face discrimination in access to work, economic assets, and participation in public and private decision making (Ki-Moon, 2015).

Increasing women’s participation in the ICT sector is important for several reasons. Specifically, increasing employment opportunities for women improves gender equality; empowering women benefits their

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communities and their offspring; and closing the gender gap in the IT work area helps to address the gap between the supply and demand of these types of jobs in today's society (Powell & Chang, 2016).

Information technology (IT) is a fast-growing sector, offering many opportunities for job and professional growth, including a range of self-employment options. Jobs in this area are often better paid and have opportunities for advancement (Beckhusen, 2016). Improving the participation of women in the IT sector, in addition to helping to close gender gaps in employment and wages, promotes countries' economic growth (Nager & Atkinson, 2016; Powell & Chang, 2016).

The gender imbalance in the IT sector starts with education, which in turn, influences the employment situation. Numerous studies have identified the low participation of women in computer and IT related careers and programs (Beyer, 2008; Katz, Allbritton, Aronis, Wilson, & Soffa, 2006; Kim, Fann, & Misa-Escalante, 2011; Mora-Rivera, Coto-Chotto, & Villalobos-Murillo, 2017; Paloheimo & Stenman, 2006; Vilner & Zur, 2006). It has been determined that multiple elements deter women from pursuing computer careers, including the image of computer science as a male domain, a lack of trust among female students despite their obvious skills, a lack of women teachers and role models, a culture that does not invite women to venture into computer science, and the importance of previous programming experience (Barker & Cohoon, 2015; Stoilescu & Egodawatte, 2010; Sullivan, Byrne, Bresnihan, O'Sullivan, & Tangney, 2015; Vitores & Gil-Juárez, 2016; Wilson, 2002). Research shows that there is no simple answer to the issue that women decide not to pursue ICT-related careers. The reasons seem to be linked to the nature of socially defined gender roles. With few exceptions, women are underrepresented at all levels in the ICT sector and IT programs.

Problem Formulation

Although ICT is a fast-growing sector; offers many job and career growth opportunities, including a range of self-employment options; and is higher paid and offers opportunities for advancement—and despite companies' and agencies' requests for more women in ICT careers—women are highly underrepresented in ICT-related careers and programs. In this chapter, we want to explore this phenomenon more closely, asking the following research questions:

- What is the rate of women's participation in different kinds of university ICT programs?
- How can women's participation in IT programs be improved at the university level?

To answer these questions, we employ two case studies—Universidad Nacional (UNA) in Costa Rica and Aalborg University (AAU) in Denmark. In the next section, we present the concepts and approaches, as well as the choice of cases, guiding our investigation.

Gender Mainstreaming

Gender equality is not only a fundamental human right but also a necessary foundation for a peaceful, prosperous, and sustainable world (Ki-Moon, 2015). Gender mainstreaming is an international acknowledged strategy and method focusing on the integration of gender and equality in the public administration and on all levels: "Gender mainstreaming is asking about the consequences of, for example, a decision, an initiative, a procedure in an organization, and if it might have unintended consequences for one gender rather than the other" (Faber, Gemzøe, & Nielsen, 2017, pp. 12–13; our translation).

Gender mainstreaming is a concept focusing on establishing equality through policies and institutional practices. The concept of "mainstreaming" must be understood as opposite to "undercurrent" policies and

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practices, and it implies that the gender equality policies, procedures, and practices are built into the *general* policies, for example, of a university and are not something living on the sidelines. Gender mainstreaming implies that gender equality policies and perspectives are integrated and mainstreamed (Faber et al., 2017).

According to the Council of Europe (n.d.), the concept of gender mainstreaming was first introduced at the 1985 Nairobi World Conference on Women. Then, in 1995, at the Fourth United Nations World Conference on Women in Beijing, it was adopted as a tool for promoting gender equality at all levels. The concept acknowledges that women and men have different needs and living conditions and circumstances, including unequal access to and control over power, resources, human rights, and institutions—including the justice system—and differences according to country, region, age, ethnic or social origin, or other factors. The aim of gender mainstreaming is “to take into account these differences when designing, implementing and evaluating policies, programs and projects, so that they benefit both women and men and do not increase inequality but enhance gender equality” (Council of Europe, n.d.). Gender mainstreaming also aims to solve —sometimes hidden—gender inequalities. Therefore, it is a tool for achieving gender equality. Gender mainstreaming has the two following dimensions: integrating a gender perspective in the content of the different policies and addressing the representation of women and men in the given policy. Both should be considered in all phases of the policy formulation process (European Institution for Gender Equality, n.d.).

Gender mainstreaming has long been emphasized in the European Union as a tool that universities should apply, and the European Union has strengthened the gender focus in big research programs like Horizon 2020, where all applications must account for how to address gender issues. In Denmark, mainstreaming was adopted as the bearing principle in the law on Equality from 2000, and in Costa Rica, in the National Policy for Gender Equality and Equity from 2007.

Fixing Women or Fixing the Organization?

Faber et al. (2017) presented two approaches to gender mainstreaming—“fixing the women” and “fixing the organization.” Examples of the former approach in universities may be mentoring programs for excellent young female researchers, summer schools in male-dominated programs for high school females, and early career advice. In this approach, “the problem is the women,” and the perspective builds on a “deficit model” focusing on why women do not measure up to higher education career standards and demands in academia (Burkinshaw & White, 2017). In the academic discourse on equality and diversity, there is an emerging understanding globally that the deficit model of women is failing to explain and change the situation in higher education. To change the situation, the organization, the systems, the structures, and not least, the appropriation and enactment in all their complexity, need to change to transform the unequal gender balances (Burkinshaw & White, 2017; Faber et al., 2017; Pischetola & Dirckinck-Holmfeld, in press). In popular terms, this latter approach can be called “fixing the organization.”

In this chapter, we adopt the two concepts on approaches to mainstreaming gender in IT programs. The contribution of the chapter is a close look at the gender distribution in the IT programs at the two universities, UNA and AAU. Based on the findings, we discuss some overall strategies for how to approach women’s participation in IT programs at the university level based on the concepts of “fixing the women” and “fixing the organization.”

To situate the two cases, we open the chapter by giving some snapshots on gender equality in the two countries, Costa Rica and Denmark, as well as relating this discussion to IT and considering how gender mainstreaming activities have been taken up. Then, we present some overall data about the two universities before we take a closer look at the gender participation in the ICT programs at UNA and AAU. In our classification of IT programs, we follow the definition used on the Futurepeople.dk website. This definition

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has been developed by heads of departments for IT programs at Danish universities, and it states, “An IT program is characterized by qualifying to work with the development and/or implementation of IT – possibly within a given professional field” (B. L. Hansen, personal communication, November 26, 2019). The Ministry of Science and Higher Education in Denmark has adopted this definition in the classification of ICT programs.[1]

Most of the data in this article are based on national and international databases, for example, Conare and UNA in Costa Rica and the primary data from Statistics Denmark and national and international reports in Denmark. The data regarding the specific ICT programs at the institutional level are based on help from the statistical offices at each university.

In both Costa Rica and Denmark, there are many concerns about identity policies and how to express gender-related issues and describe the sexes. The data we are using are classified into two sexes, females and males. Following this, the article will reduce its perspectives to look at diversity and equality from the perspectives of the two sexes of females and males.

The Choice of Costa Rica and Denmark as Cases

Often, research and consultancy reports situate findings in relation to countries that are frequently compared. We often compare Denmark with other Organization for Economic Co-operation and Development (OECD) countries, and we normally compare Costa Rica with Latin America. However, due to opportunities based on a long-term collaboration between the authors on higher education issues in a Danish and Costa Rican context, we have found it useful to make use of these opportunities to cut across the traditional comparisons in this study. By looking into two cases in relatively different contexts, we expect to obtain new and fresh inputs to this important research and action area of mainstreaming gender in relation to ICT.

NATIONAL CONTEXTS

Global Development Indicators

To place Costa Rica and Denmark in a scenario related to the participation of women in work and educational backgrounds, in this section, we delineate some indicators of the Global Gender Gap Index of the World Economic Forum (WEF, 2019). The WEF’s Global Gender Gap Index classifies countries according to the gender gap calculated between women and men within each country in four key areas—health, education, economy, and politics. Its objective is evaluating the state of gender equality in a specific country. As such, the report does not rank absolute gender equality; rather, it ranks countries based on the state of relative gender equality in each nation. Specifically, the Global Gender Gap Index analyzes the following areas:

- Economic participation and opportunity: highly skilled salaries, participation, and employment;
- Education: access to basic and higher levels of education;

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[1] This article uses the terms *ICT* and *IT* interchangeably, depending on the source. In general, this employ uses ICT to underline a broader and inclusive definition integrating IT (computers, systems networking, software, and other equipment for managing information) and communication technologies (social media, computer networks, audio/video processing, and transmission). Further, the authors (and the Danish definition) integrate the social and humanistic aspects of use, design, and implementation.

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- Health and survival: life expectancy and sex ratio; and
- Political participation: representation in decision-making structures.

For the 2020 report, 153 countries were analyzed; the rankings shown in Table 1 position Costa Rica and Denmark in relation to this number of countries. To see the progress over time, the data corresponding to 2006 (the first year the index was calculated) and 2020 are shown. A score equal to 1 signifies equality between males and females. Values greater than 1 favor women, and values less than 1 favor men. In the Danish context there has been some discussion about the methods by which the index is calculated (Morgen, 2019).

In the 2020 ranking, Denmark occupies position 14 and Costa Rica position 13, but both have the same value (0.782) on the Global Gender Gap Index. From 2006 to 2020, Costa Rica moved from #30 to #13, while Denmark dropped from #8 to #14.

The sub-index of Economic Participation and Opportunity is related, among other things, to the participation of women in the labor market and equal pay for similar jobs. Denmark's score in the labor force participation rate for 2020 is 0.94 (female = 76.2, male = 81.5), while that of Costa Rica is 0.64 (female = 51.8, male = 81.3). This means that, while both countries' indexes favor men, Denmark is much closer to closing the gender gap. In terms of equal pay for similar jobs, Denmark's score is 0.69, while Costa Rica's score is 0.57; this indicates that a wage gap exists in both countries, but it is smaller in Denmark than it is in Costa Rica. Overall, Denmark has a better position (#41) than Costa Rica (#112) does, but both countries have fallen more than 20 positions from 2006 to 2020.

Table 1. Global Gender Gap Index (WEF, 2019)

	Costa Rica #Ranking (score)		**Denmark #Ranking (score)**	
	2006	**2020**	**2006**	**2020**
Global Gender Gap Index	**30 (0.694)**	**13 (0.782)**	**8 (0.746)**	**14 (0.782)**
Economic Participation and Opportunity	89 (0.522)	112 (0.607)	19 (0.708)	41 (0.735)
Educational Attainment	32 (0.995)	33 (1)	1 (1)	1 (1)
Health and Survival	1 (0.980)	60 (0.977)	76 (0.972)	101 (0.971)
Political Empowerment	15 (0.277)	6 (0.545)	13 (0.305)	17 (0.421)

Both countries have progressed to close the Educational Achievement gap, and as of 2020, they have reached gender parity. In fact, for Costa Rica, the female/male proportion in tertiary education enrollment is 1.21% (female = 60.7%, male = 50%), and for Denmark, it is 1.37% (female = 93.6%, male = 68.4%). In both countries, the participation of women in tertiary education is greater than that of men; however, while this participation is greater than 90% in Denmark, in Costa Rica, it has reduced to 60% on average; this is one of the reasons that Denmark is in position #1 and Costa Rica is in position #33.

Regarding the Health and Survival sub-index, both countries show a slight score decrease from 2006 to 2020. For 2020, Costa Rica has a better ranking position than Denmark does (#60 vs. #101).

For the Political Empowerment sub-index, for 2020, Costa Rica is in position #6 (0.545) and Denmark in position #17 (0.421). This sub-index is composed, among other things, of the following indicators:

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percentage of women in parliament (Costa Rica: 0.84, Denmark: 0.64), and percentage of women in ministerial positions (Costa Rica: 1, Denmark: 0.75). The good position of Costa Rica in this sub-index can be explained by the recent fast progress of the country in these two aspects. For the 2020 data, the participation of women in parliament in Costa Rica is 45.6% and the participation of women in ministerial positions is 51.9%, while for Denmark, the participation of women in parliament is 39.1% and the participation of women in ministerial positions is of 42.9%.

In summary, both Costa Rica and Denmark occupy privileged positions in the Global Gender Gap Index, with both countries in the top 10%. Despite these good results, efforts should continue to increase female participation in the workforce, eliminate the gender pay gap for similar positions and ensure there is a more equitable distribution of positions of power and decision making at the national level.

Costa Rica's National-Level Initiatives

Costa Rica has ratified international conventions on gender equity and enacted specific laws and policies to advance gender equality and equity, which affect the field of education. Among others, the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW, 1979), the Law for the Promotion of Social Equality of Women (1990), Law Against Sexual Harassment in Employment and Teaching (1995), Law on the Promotion of Responsible Parenthood (2001), Law of Criminalization of Violence against Women (2007), National Policy for Gender Equality and Equity (PIEG, 2007–2017), and the National Policy for Equality Between Women and Men in Training, Employment and Enjoyment of the Products of Science, Technology, Telecommunications, and Innovation 2018–2027 (2018). This last policy defines four areas of interest, which are as follows: (1) the attraction of women to science and technology since early childhood; (2) the education, training, and retention of women in technical and professional careers related to science and technology; (3) female employment in the science and technology sector; and (4) the use and enjoyment of scientific and technological products by women (Ministerio de Ciencia, Tecnología y Telecomunicaciones MICITT, 2017).

In addition to national policies, different activities are carried out by organizations from different sectors (public, private, nongovernmental, and international organizations) that aim to promote the vocations of girls and boys in science and technology. There are programs like science and technology fairs; mathematics, physics, chemistry, biology, and robotics competitions; and specialized courses in programming apps and webs organized by the Omar Dengo Foundation, Sulá cooperative Batsú, and MenTe Network; and Meetings of Women in Science and Technology in alliance with institutions and organizations of the public, academic, and private sector, as well as international organizations, such as the Federated College of Engineers and Architects (CFIA), Organization of Ibero-American States for Education, Science and Culture (OEI), National Learning Institute (INA), National Women's Institute (INAMU), Ministry of Public Education (MEP), Ministry of Science, Technology and Telecommunications (MICITT), and INTEL. Universities also have projects aimed at strengthening the scientific and technological vocations of women. However, all these efforts are carried out independently, which leads to limited coverage (MICITT, 2017).

Denmark's National-Level Initiatives

There are three legislations of especial relevance in Denmark, namely, the legislation on "Gender Equality" from 2000, the addendum to the legislation from 2013 (Ligestillingsloven, 2019), and the legislation on "Prohibition Against Discrimination" from 1987 (Justitsministeriet, 1987). The aim is to actively establish gender balance, equal integration, equal influence, and equal opportunities in all aspects of life based on the universal principles of women and men being equal. The law also actively counteracts direct and indirect

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discriminatory action and practices because of gender, sexual orientation, race, or disability. With the 2013 addendum to the gender equality legislation, all universities and other public institutions are obliged to make reports on equality every second year to allow the government to follow and monitor gender equality in public institutions.

Over the years, there have also been some expert groups established by the Danish government, for example, a charter for more women in leadership and a task force on strengthening women's participation in research (Faber et al., 2017). In the European Union, there has been a strong focus on gender mainstreaming as one out of six priority areas in the strategic plan for research and innovation (European Commission, 2015).

From the initiatives carried out by both countries, it is clear that there is a genuine interest in strengthening and creating strong and effective policies to promote gender equality and equity. Both countries rely on a universal conception of promotion and protection of human rights, promotion of human development, and gender equality. Both countries are in the top 10% of positions in the Global Gender Gap Index. However, while Costa Rica has been climbing rather radically in the global ranking indicators, moving from position #30 (2006) to #13 (2019), Denmark is decreasing year by year, from #8 in 2006 to #14 in 2019.

Gender Situation Trends in Costa Rica

The 2018 Costa Rica State of the Nation Report indicated that, as a long-term trend, female labor insertion in Costa Rica has grown steadily, especially in the 1990s and beginning of the 21st century; however, at the same time, it has stagnated in recent years. The study showed that, in Costa Rica, women face a triple barrier—insertion (participation in the workforce), selection (access to employment), and valuation (wage gap). Even if they have high qualifications, women more frequently face problems of unemployment, underemployment, income gaps, little access to productive resources, and occupational segmentation patterns, which affect their rights and opportunities for personal and professional development. These difficulties not only harm women and their families but also the country, and this has reduced the possibilities of taking advantage of this important contingent of labor and its potential to increase national productivity and competitiveness (Programa Estado de la Nación, 2018).

The female unemployment rate persistently exceeds the male rate. During the 2010–2017 period, the average gap was 3.5 percentage points. In contrast, participation and occupation rates have remained with differences of around 30 points in favor of men (Solórzano, 2018). Solórzano's (2018) study highlights four findings, which are as follows:

- The educational profile of women is more favorable: a third have higher education versus 21% of men;
- There is a greater segmentation of female employment by branches of activity since women focus mainly on services, such as education, health, domestic, administrative or commercial services, unlike men, who have a more diversified distribution;
- Although the private sector is the main employer for both sexes, the public service has a greater weight among women (19%) than among men (11.5%); and
- Eighty percent of employed women reside in urban areas versus 72.4% of men. This confirms the low presence of rural women in the labor market.

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Another problem that women face is discrimination in employment, especially in terms of wages. If income were determined based on the type of position and human capital endowments, women should receive higher salaries than men do. However, this does not happen due to gender discrimination, which results in unequal valuations in the attributes of workers (Solórzano, 2018).

As for university education, in 2016, 53.3% of the people enrolled in the first semester of state universities were women, a percentage that has changed little since 2013. In that same year, 59.1% of the diplomas awarded in the state university sector were given to women. In 2015, for every 100 men who obtained a licentiate's degree, 187 women also did so, and for every 100 men who obtained a master's degree, 142 women also achieved this level of education (Programa Estado de la Nación, 2017). Despite greater education, professional and non-professional women remain inserted in traditionally feminine activities, which are less well paid and do not correspond to the most dynamic sector of the Costa Rican economy. At the level of state universities, in the 2016–2018 period, most of the people who enrolled were in the areas of economic sciences, education, and basic sciences. Women predominate in five of the eight areas of knowledge, with a participation rate greater than 60% (economic sciences, education, social sciences, arts and literature, and health sciences). Their participation is significantly lower in the areas of basic sciences (28%) and engineering (35%) and only slightly less in the area of natural resources (48%) (Conare, 2019).

Regarding the IT/Science, Technology, Engineering and Mathematics (STEM) context, according to the State of Education Report 2019 (Programa Estado de la Nación, 2019), Costa Rica shows progress in the relative importance of careers in the STEM area, but it continues to face challenges when it comes to reducing gender gaps. In 2018, only 37% of the available university educational opportunities in the country were in the STEM area, and there were notable gender gaps in enrollment and graduation. Despite improvements in women's participation in the STEM degree qualification (43% in 2000, 47% in 2005, and 52% in 2010 and 2017), gender gaps persist in some knowledge areas. In careers like Physics, Computing, Mechanical Engineering, Electronic Engineering, and Electrical Engineering, more than 80% of the enrollment corresponds to men. Meanwhile, women predominate in every career in the area of Health Sciences. The STEM careers in which there is greater sex parity in enrollment are Geology, Chemistry, Agricultural Engineering, Industrial Engineering, Chemical Engineering, and Architecture (Programa Estado de la Nación, 2017).

In Costa Rica, the participation of women in science and technology is unequal compared with that of men, a situation that is detrimental not only to women but also to the country's social and material progress. Specifically, in the digital technology sector, which is characterized as a growing sector both in production and sources of employment, and which generates many personal and professional opportunities, mostly men are present (MICITT, 2017). According to data provided by Conare (personal communication, 2019), from 2016 to 2019, the percentage of women pursuing careers related to computer science and information technology at state universities remained at 21%. In these 4 years, of a total of 42,401 people who entered state universities to study careers in these areas, only 8,904 were women. The same trend remains in the degrees granted. Of a total of 4,157 students who graduated from 2016 to 2018 in these study programs, only 869 were women (21%).

Gender Situation Trends in Denmark

Denmark is expected to be an equal society regardless of gender, race, or sexual orientation; however, statistics show great divides, and the indicators of the Global Gender Gap Index of the WEF (2019) confirm a decline in the country's global position. In this section, we present an overall view on some of these divides. Compared with other EU countries, Denmark is also doing rather poorly, and it is below the countries we would normally compare it with. Focusing on academic staff at universities, only 34.8% are

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women in Denmark, compared with 36.2% in Norway and 37.2% in Sweden and a little above the 33 % EU-28 average. The highest numbers in Europe are found in Latvia and Lithuania, at 52.4% and 52.8%, respectively (European Commission & Directorate-General for Research and Innovation, 2016 p. 65) (Faber et al., 2017).

Despite the initiatives, reports show that Danish women face several barriers, which are as follows: valuation (wage gap); a lack of female leaders, especially in top management; and occupational segmentation patterns. Men are earning 18% more than women on average, although women are more educated than men and men and women have approximately the same occupational experience (Ligestillingsudvalget, 2011). This is also related to job segregation, where 33% of all women work in professions with more than 80% women, while 25% of all men work in professions with more than 80% of men (Minister for Ligestilling, 2019). Job segmentation seems to have important consequences for the wage gap during a full working life. As an example, a police officer will earn 2.5 million DKK more than a midwife will over the career despite same educational level, and a building manager (professional bachelor level) will earn over 3 million DKK more than a bio-analyst (professional bachelor-level) over the lifetime (Ligestillingsudvalget, 2011). However, even within the same category of jobs and with similar qualifications, there is a wage gap of 4–7% between men and women (Minister for Ligestilling, 2019, p. 15).

In Denmark, the gender distribution in management in general favors men (56%) over women (44%). However, when it comes to top management, the distribution is even more drastic, representing men at 70% versus women at 30% (UDENRIGSMINISTERIET/MINISTER FOR LIGESTILLING, 2018)

State institutions are obliged to work on mainstreaming activities. When it comes to staff, most institutions have policies (Rambøll, 2018); however, concerning their core activities (e.g., teaching, research, and outreach in universities), few institutions have policies (only 36%), and 34% do not find it necessary to have policies. This tendency of not prioritizing gender policies in core activities grew from 2015 to 2017 (Rambøll, 2018).

Concerning the patterns regarding higher education, women outpace men. In 2018, 882,000 people (25–45 years old) in Denmark did not hold a higher education degree. Of them, 57% were men and 43% were women (Statistics Denmark, 2019).[2] In 2010, there were approximately 1 million people without higher education with percentages of 55% men and 45% women at that time. Thus, the tendencies over the last 10 years have for higher education (short to long term) have shown that the number of people who do not complete an higher education degree is decreasing, while the gap between the sexes is growing slightly in favor of women.

If we look at patterns at the university level, in 2018, there were 65,000 students who were actively studying for a master's degree,[3] including 44% male students and 56% female students. In 2010, the numbers were slightly higher, at 65,500 students, but with the same distribution between males and females. Thus, in the Danish system, the number of active students in master's programs is rather stable. When it comes to the number of students enrolling and graduating, we find similar patterns. In 2010, approximately 20,000

[2] The numbers and percentages have been rounded to whole numbers.
[3] In the "Danmarks Statistikbank," data are organized at both the bachelor's and master's levels regarding universities. In Denmark, the overall educational pattern at the university level has been that students graduate with a master's degree, with a direct transition from the bachelor's to master's level. Extremely few university students graduate with only a bachelor's degree.

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students enrolled in a master's program, comprising 44% males and 56% females. In 2010, approximately 14,000 students graduated with a master's degree, representing 46% males and 54% females. In 2018, these numbers had increased. Enrollment grew to 27,500 students, with a slight change in the distribution, comprising 45% males and 55% females enrolled. For graduation, there was a rather significant rise to 23,500 graduates. There is a tendency whereby the divide between males and females is widening, with 2% less males are graduating (44%) and 56% of graduates being female (Statistics Denmark, 2019).

The same patterns can be found at the undergraduate level. In 2018, 77,000 students were studying for a bachelor degree (BA), comprising 44% males and 56% females. Enrollments represent 27,000 students, of which, 47% were males and 53% females. The tendency shows a slight rise for the percentage of men and a decrease for women. This can be explained by the increase in enrollment in STEM programs in engineering and natural science, which attract more men than women in the Danish context, and a simultaneous reduction in enrollment in the humanities. However, more women than men are still enrolling. When it comes to the number of individuals graduating with a bachelor's degree, this has reached 18,000, and the share of males (46%) and females (54%) is close to the pattern in master's programs but with a slightly bigger share (2%) of males. However, more women than men are still graduating with a bachelor's degree in terms of numbers, representing approximately 1,500 female students every year.

If we look at all eight universities in Denmark, women predominated in seven out of nine knowledge areas at the BA level on average for the years 2016–2018 (education, humanities and theology, arts, social science, food, biotechnology and laboratory technology, agriculture, nature and environment, health sciences). Men are only predominant in Science and Technical Science (Engineering), and the women's participation is significantly lower in these areas, at only 40% and 30%, respectively. This represents active, graduated, and enrolled students in these subject areas (Statistics Denmark, 2019).

When it comes to the STEM programs (Science, Technology, Engineering, and Math, including ICT programs), the gender distribution is uneven in favor of men. The enrollment of women in 2019 at the national level was 32%, whereas men represented 68% of enrollment in all STEM programs (including short- and medium-cycle higher education). The number of students studying STEM in higher education increased by 15% from 2013 to 2019. In the same period, other knowledge areas have only increased by 3%. The numbers cover all higher education, including short- and medium-cycle higher education. The number of BA students in 2019 enrolling in a STEM program was 7,916 (Statistics Denmark, 2019, p. 3), and the number of students enrolling in IT programs at the BA level was 3,345 (Statistics Denmark, 2019, p. 5).[4]

General Comments

The integration of the gender perspective must be the responsibility of all countries and institutions under the leadership of the administration. A political commitment and legal framework are required for the development of a successful gender integration strategy, in addition to a clear action plan (European Institution for Gender Equality, n.d.). Costa Rica and Denmark have legislation on equality based on universal principles for equality. However, despite the legislation and many policy initiatives, it seems both countries are missing some consequences in terms of a lack of implementation of equality actions.

[4] The report underlines that more students are enrolled in IT programs at the master's level (both academic and professional); however, these students are not included in this report, which builds on data from the Danish Ministry of Higher Education and Science.

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In both countries, women face similar barriers, such as low wages and occupational segmentation patterns, as well as a lack of representation in top leadership; regarding the last point, the disfavor for women in Denmark is more distinct than that in Costa Rica. In both Denmark and Costa Rica, men earn better wages than women do on average, although women outpace men with respect to formal educational degrees. In both countries, the number of students enrolling and graduating with a university degree has been rising over the last 10 years, and the countries share a pattern of more women than men studying in a university program, more women graduating relative to men, and more women enrolling in tertiary education. In addition, the countries share a common pattern related to gender in the knowledge areas. In both countries, women predominate in most knowledge areas. Only in the knowledge areas of science and technical sciences are women underrepresented in both countries, with similar participation levels—in Denmark, women make up 40% and 30% of participants in these subject areas, while in Costa Rica, they participate at rates of 28% and 35% in science and technical science (engineering). In science, Denmark has better female participation, while in engineering, Costa Rica is doing better.

In the IT and STEM areas, most students in both countries are men; only 30% are women. This reduces the chances of both countries increasing their national productivity and competitiveness in the IT sector.

In sum, gender mainstreaming has become a central pillar of political and development discourse. However, the implementation of these promises has been disappointing. It is necessary to rethink the link between policy and implementation, recognizing that both are political processes, and although policies set agendas, policies and their implementation are both deeply influenced by social factors, which must be addressed comprehensively (Parpart, 2014).

THE UNIVERSITY LEVEL

UNA Institutional Initiatives

The UNA has more than 25 years of taking steps aimed at strengthening gender equity at the institutional level. These efforts began in the mid-1980s and evolved from the creation of the Interdisciplinary Center for Women's Studies (CIEM) in 1987—which became the Institute for Women's Studies (IEM) in 1991—to the adoption of institutional policies on sexual harassment in 2009 and the Policy for Gender Equality and Equity in the National University (PIEG-UNA; UNA, 2016). The latter raises elements related to the promotion of the equal participation of women and men in decision-making bodies, guaranteeing the access and development of the university community on equal terms. It favors the use of inclusive language in all forms of internal communication and the external relations of the university.

Regarding gender mainstreaming in the university curriculum, UNA has assumed the commitment to promote a professional training curriculum that considers the inclusion of gender with a humanistic and human rights perspective as a transversal axis. An important achievement in this line is the professional development course "Gender Mainstreaming Approach in University Teaching," which has been developed since 2008 jointly between the Program of Academic Evaluation and Professional Development and the Institute of Women's Studies (UNA, 2016).

UNA in Numbers

Although the National University has gradually advanced in the construction of equality, gender biases and stereotypes that limit the full access and effective integration of women persist. Data from October 2019 (Universidad Nacional, 2019) show that, regarding faculty staff, women represent 49.89% of university

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staff, so there is virtually numerical parity at the National University. However, this condition is not expressed in the management and decision-making spaces, which are characterized by a majority presence of men (Table 2). Based on data from October 2019, UNA has 3,640 employees, of which 1,816 are women and 1,824 are men; that is, the institution has an almost equal proportion of male and female workers, distributed as shown in Table 2.

Table 2. Institutional Authorities at UNA, October 2019

	Female	**Male**
Faculty staff	47%	53%
Administrative staff	53%	47%
Institutional authorities	44%	56%

Institutional authorities include rectors, vice-rectors, deans, vice-deans, directors, deputy directors, and members of the University Council. In the academic sector (teaching staff and institutional authorities), 47% are women and 53% are men. Table 3 shows the distribution of academic staff according to their academic category, where category 90 corresponds to "associate professor" and 91 to "full professor" (*UNA transparente*, 2019, data from October 2019).

Table 3. Academic Categories at UNA, October 2019

Academic category	**% of UNA academic staff**	**Female**	**Male**
Instructor/adjunct (88)	42%	47%	53%
Lecturer professor (89)	19%	55%	45%
Associate professor (90)	27%	46%	54%
Full professor (91)	11%	35%	65%

The greatest gaps between academics are found in the highest category (91), where the number of men is almost double that of women. At UNA, women are placed in differentiated fields of knowledge and performing specific functions that tend to have less recognition and social prestige, which in turn, decreases their chances of promotion in the academic career categories; as the category progresses, their presence decreases.

Regarding students, during the 2010–2018 period, 166,366 students enrolled in the university, comprising 91,137 (55%) women and 75,229 (45%) men. There is a clear trend in enrollment, and more women than men enroll each year. During the 2010–2018 period, 29,268 students graduated from the university, 17,615 (60%) correspond to women and 11,653 (40%) to men. As of December 2018, UNA had 19,623 students (Universidad Nacional, 2019).

AAU Institutional Initiatives

AAU established its first diversity taskforce in 2007. From the beginning, it had a broad focus on gender, nationality, sexuality, and religion; however, in practice, the primary focus was on gender equality (Faber et al., 2017). This work was followed up with a rather broad-spectrum strategy in 2009–2012 and 2012–2015 focusing on research, the work environment, career strategies, data documentation, and so on. In this period, the top management—including deans of the university—was 50–50% women/men; however, the numbers of heads of department were uneven, with 4 women versus 15 men. The diversity strategies from this period were comprehensive, focusing on mainstreaming the organization to actively establish a better gender balance, equal integration, equal influence, and equal opportunities for men and women, and as such, the strategies were in line with the spirit of the legislation on equality, as well as integrating the Danish

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charter about women in management. More women were hired in academic positions, the number of female PhD students was increasing, and there was more equality at some of the management levels (top management). However, the deans and heads of departments were not really made accountable for the implementation (Faber et al., 2017).

The diversity work at AAU was restructured in 2015; the ongoing committee was closed down, and a new committee was established (Udvalg for Ligestilling and Diversitet, ULD). This committee started a new 5-year strategic plan at the overall university level, while faculties and departments are expected to work out and implement action strategies at the curriculum level. At the university level, screening of job advertisements for bias in relation to gender, age, and nationality is being tested (T. Strandvig, personal communication, November 28, 2019). At the faculty level, Science and Engineering (ENG) and Technical Design and IT (TECH) have ambitious strategies. By 2025, TECH wants to have 30% female participation in the technical IT programs, and ENG wants to have 50% female participation in engineering programs. The faculties are running several equality projects, which are as follows (N. B. Christensen, personal communication, December 2, 2019):

- Communication and campaign efforts aimed primarily at female high school students;
- Female students as role models;
- Event-based activities, such as IT camp for female high school students;
- Equal representation of men and women in educational information material;
- Guidelines for handling student experiences of abusive behavior at AAU, especially for tutors;
- Communication efforts in relation to engaging students for governing bodies;
- Student-driven projects regarding layout of physical learning environments; and
- An onboarding course, a focus on internal culture in education, female mentors, and composition based on different group formation formats.

AAU in Numbers

Faber et al. (2017) used the metaphor "leaky pipeline" for the situation at AAU. The recruitment to the academic positions is unequal, and more women than men are "falling out" of the recruitment system to higher positions. This imbalance has also been constant at the national level; however, as documented by Borchorst (as cited in Faber et al., 2017) it has been even more imbalanced at AAU.

What we see in a snapshot of the distribution gender among the employees at AAU (2012/2016) is that the distribution is rather stable (Faber et al., 2017). At the lowest levels in the career steps, we find a tendency towards a more equal distribution of PhDs and assistant professors (second and fifth dots). However, when it comes to the higher positions and permanent positions as associate and full professors, the distribution is imbalanced at 30% women versus 70% men at the levels of associate professors and professors with special duties (six and seven dots); for full professors, it is highly imbalanced, with only 17% females versus 83% males (nine dots). The eight-dot level concerns professors within Health, where gender is also extremely polarized.

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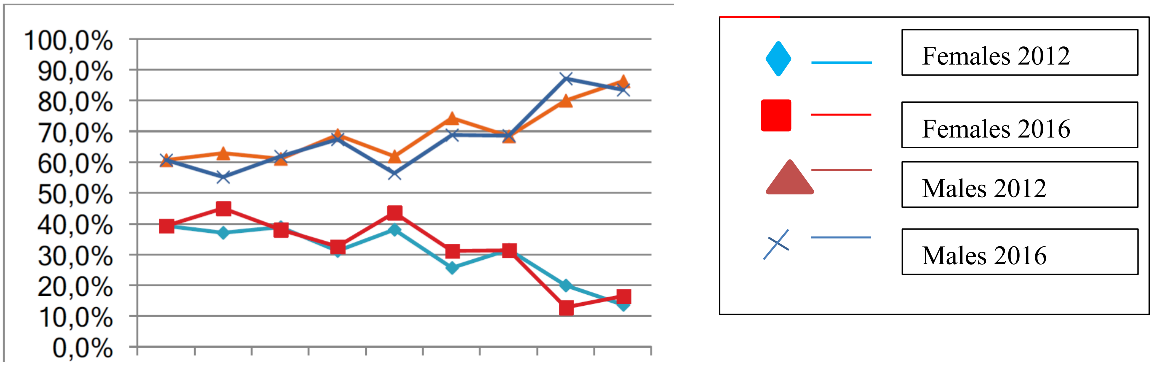

Figure 1. Gender distribution on career steps in AAU (based on Faber et al., 2017, p. 29).

The patterns in the various faculties are diversified. In Humanities, females are overrepresented in most of the career steps; however, the two permanent position steps—associate and full professors—are underrepresented, with only 35% of full professors being women. In the faculties of ENG and TECH, the imbalance is extreme. Especially in the topmost career steps as full professors, the proportions of women are as low as 7% (ENG) and 12% (TECH).

There is a category of professors with special duties, involving a 5- to 8-year temporary position at the professor level. It is interesting to see, that within all faculties, this category has a much higher percentage of women than that of full professors.

Regarding women's representation in top- and middle management, Table 4 shows a divided picture except for top management, as the rector is male and the vice-rector is female. The real upper middle management is dominated by men; in fact, all five deans are men. On average, the predomination of men is most extreme when it comes to the full professors.

Table 4. Gender Distribution Among Top and Middle Management and Full Professors (Faber et al., 2017)

	Male %	**Female %**
Rector & vice-rector	50.0	50.0
Deans and heads of department	70.8	29.2
Administrative chefs	71.4	28.6
Full professors	83.0	17.0

Regarding students, during the 2009–2019 period, 193,085 students were registered in the university; at the bachelor level, there were 115,686 students, comprising 46% women and 54% men. At the master's level, 77,399 students were enrolled, with a slightly larger proportion of females (51.8%) versus males (48.2%). These numbers seem stable over the years, with a slight tendency to show more males at the bachelor level, both numerically and in percentages, around 2012–2016. At the master's level, the opposite pattern can be seen, with more females both numerically and in percentages. During the 2009/10–2018/19 period, 47,993 students graduated from the university; there were 23,574 at the bachelor level, with 48% females and 52% males, while there were 24,419 at the master's level, with 51.2% women and 48.8% men (Clickview, 2019). However, even if the overall numbers are rather even between the sexes, there are big differences between the faculties at both the bachelor's and master's levels. ENG, TECH, and humanities (HUM) (bachelor and master) all have a predominance of one gender with around 70% (HUM bachelor 68%). In ENG and TECH, males predominate, while HUM is predominated by females (Clickview, 2019).

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General Comments

Both universities are about 45 years old, and both were established as reform universities with a special aim of providing access to the universities for more students and working together with local communities and business for regional and national development. The size of the universities is also approximately the same: They are mid-sized universities with 18,000–20,000 students enrolling per year.

Both universities have taken steps aiming at strengthening gender equity at the institutional level. An important achievement in this line with regards to the curriculum in UNA is the professional development course "Gender Mainstreaming Approach in University Teaching." At AAU, most initiatives regarding the gender mainstreaming curriculum take place at the faculty level. Especially, TECH and ENG are engaged in systematic initiatives. Despite the initiatives, the programs at the universities are predominated by one gender, especially at AAU, for the three faculties; specifically, ENG and TECH are predominated by men, while HUM is predominated by women, with more than 70% domination of one gender.

When it comes to staff and management, both universities are also facing challenges related to the disfavor of female leadership. In all categories of academic careers, males are outpacing females; however, the category of full professors is especially polarized at both universities, most obviously at AAU, where only one in every six full professors on average is a woman. At UNA, one in every three full professors is a woman. These numbers are even more extreme at the faculty level, where in ENG and TECH at AAU, only 1 in every 14 full professors in ENG is a woman and 1 in every 8 full professors in TECH is a woman. When it comes to institutional authorities and management leadership, these positions are all dominated by men at both universities; however, the situation is much more polarized at AAU compared with UNA. UNA has a distribution of 56–44% men–women, while AAU has a distribution of 71.4–28.6% men–women.

Overall, although both universities are engaged in gender mainstreaming actions, the patterns for both universities are an unequal distribution of women and men among the institutional authorities and in the highest career steps in disfavor of women. The imbalance is especially severe at AAU.

IT-RELATED PROGRAMS

In this section, we present information regarding IT-related study programs at both universities. As described in the introduction, the selection of IT programs was based on the definition used on the site Futurepeople.dk.

For the data analysis, we use the following scale:

- Extremely divided: 90–100% one gender versus the other;
- Very divided: 70–89% one gender versus the other;
- Less divided: 56–69% one gender versus the other; and
- Equal: 45–55% in both genders.

ICT Study Programs at UNA

The ICT-related careers at UNA are distributed into two schools. The School of Informatics has two bachelor´s programs—Educational Informatics and Systems Engineering—and three master's programs—Technology and Educational Innovation, Information Technology Administration, and Technological Innovation Management. The School of Geographical Sciences has a diploma degree in Cartography and Digital Design and a master's degree in Geographic Information Systems and Remote Sensing.

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Enrollment

Of the 23,621 students who enrolled during the 2010–2018 period, 18,365 (78%) were male and 5,256 (22%) female, with the distribution given in Table 5.

Table 5. Enrollments in the IT Programs at UNA (UNA Departamento de Registro, 2019)

	Female		**Male**		**Total**	
PROGRAM	**N**	**%**	**N**	**%**	**N**	**%**
Educational Technology (bachelor)	348	45%	424	55%	772	100%
Engineering in Information Systems (bachelor)	4,172	20%	16,754	80%	20,926	100%
Technology and Educational Innovation (master)	108	57%	81	43%	189	100%
Information Technology Administration (master)	137	24%	434	76%	571	100%
Technological Innovation Management (master)	71	39%	109	61%	180	100%
Cartography and Digital Design (diploma)	393	44%	496	56%	889	100%
Geographic Information Systems and Remote Sensing (master)	27	29%	67	71%	94	100%
TOTAL	**5,256**	**22%**	**18,365**	**78%**	**23,621**	**100%**

In general, IT-related careers at UNA are dominated by males in terms of enrollment. Three of the programs (Engineering in Information Systems, Master of Information Technology Administration, and Master of Geographic Information Systems and Remote Sensing) are considered "very divided." All three have more than 70% average male representation. The program with the lowest female participation is the Engineering in Information Systems (only 20% on average), which can be considered the main program of IT studies in UNA and is based on the curriculums of Information Systems of ACM -Association for Computing Machinery- (one of the core computer disciplines). From 2010 to 2018, 20,926 students enrolled in this program, and only 4,172 of them were women.

Three programs (Cartography and Digital Design, Master of Technological Innovation Management, and Master of Technology and Educational Innovation) are classified as "less divided" programs, but while the first two have a male predominance, the latter has a female predominance. This program has average female participation of 57%, and its educational goal is to train professionals in the use and application of digital technology to lead educational innovation through the development of projects and the redefinition of learning and teaching processes. From 2010 to 2016, the participation of males and females was rather equal (around 55% female), but in 2017 and 2018, the female participation increased to 70%; consequently, the male participation has decreased to 30%.

In the Master of Technological Innovation Management program as well, gender participation has changed over the years. From 2010 to 2012, female participation was quite low (around 25%), but from 2013 to date, this participation has increased to approximately 45%. A similar behavior is evident in the gender participation in the Cartography and Digital Design program; from 2010 to 2013, female participation was 37% on average, but since 2014, it has increased to 50% on average.

Finally, the Bachelor of Educational Technology is the only program that can be considered "equal" in terms of enrollment. It has a female participation of 45% and male participation of 55%. This program studies how digital technologies can improve teaching and learning processes. Enrollment has decreased from a total of 217 students in 2010 to only 4 students in 2018.

From the results described above, it can be concluded that, even when there is a strong male predominance in the general average (at almost 80%), there has been a tendency in the last 5–6 years to have more female

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participation in two of the programs (Technological Innovation Management and Cartography and Digital Design). In three programs (Geographic Information Systems and Remote Sensing, Information Technology Administration, and Engineering in Information Systems), males have shown a large predominance throughout the period, and just one program (Technology and Educational Innovation [master]) has had a female predominance throughout most of the years in the studied period.

It is interesting to note that the programs that have better female participation are those that can be considered as more oriented to "soft technology." Soft technology refers to the technologies that involve human factors. According to Jin (2002), "Soft technology is the intellectual technology around individuals, human thinking, ideology, emotion, value view, world view, human and organizational behavior as well as human society for creation and innovation" (p. 3).

Graduation

At the graduation level, Table 6 shows data from nine study programs (in relation to the seven programs in Table 5) because the Information Systems Engineering career comprises three degrees—Diploma in Programming Computer Applications, Engineering in Information Systems, and Informatics. Of a total of 3,970 graduates during the 2010–2018 period, 2,987 were men (75%) and 983 were women (25%).

Table 6 Graduates from the IT Programs at UNA (UNA Departamento de Registro, 2019)

	Female		**Male**		**Total**	
PROGRAM	**N**	**%**	**N**	**%**	**N**	**%**
Educational Technology (bachelor)	40	52%	37	48%	77	100%
Programming Computer Applications (diploma)	384	23%	1,288	77%	1,672	100%
Engineering in Information Systems (bachelor)	347	22%	1,223	78%	1,570	100%
Informatics (licentiate)	46	24%	144	76%	190	100%
Technology and Educational Innovation (master)	27	56%	21	44%	48	100%
Information Technology Administration (master)	47	24%	147	76%	194	100%
Technological Innovation Management (master)	21	40%	31	60%	52	100%
Cartography and Digital Design (diploma)	64	46%	75	54%	139	100%
Geographic Information Systems and Remote Sensing (master)	7	25%	21	75%	28	100%
TOTAL	**983**	**25%**	**2,987**	**75%**	**3,970**	**100%**

Five of nine programs are considered "very divided" in terms of graduation (Programming Computer Applications [diploma], Engineering in Information Systems [bachelor], Informatics [licentiate], Information Technology Administration [master], and Geographic Information Systems and Remote Sensing [master]). In all of them, female participation is under 25%.

Two programs are considered "less divided" (Technology and Educational Innovation [master] and Technological Innovation Management [master]), but the former has a female predominance (56%) and the latter a male predominance (60%). Finally, two programs can be considered "equal" (Educational Technology [degree] and Cartography and Digital Design [diploma]); however, the first has a slight female predominance (52%) and the second has a slight male predominance (54%).

While for some programs (Educational Technology, Technology and Educational Innovation, Technological Innovation Management, and Cartography and Digital Design), the pattern of predominance changes in some years from men to women or vice versa, in others (Programming Computer Applications, Engineering in Information Systems, Informatics, Information Technology Administration, and Geographic Information Systems and Remote Sensing), the predominance has been masculine throughout all 9 years

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(2010–2018). As with enrollment trends, the programs that have better female participation in terms of graduation rates are those that can be considered "soft technology programs".

Faculty staff

Five of the study programs analyzed in the previous paragraphs belong to the School of Informatics and two to the School of Geographical Sciences. If we study the composition of the faculty staff of these schools, we uncover the following information (Universidad Nacional, 2019): At the School of Informatics, for October 2019, the academic staff was composed of 54 people, 18 of them women (33%) and 36 men (67%), and at the School of Geographic Sciences, for October 2019, the academic staff was composed of 24 people, 10 women (42%) and 14 men (58%).

In both schools, there is a male predominance among teaching staff; however, this predominance is higher in the School of Informatics, which is the school that has the two study programs with a high male predominance of students (around 80%). Some studies (Buzzetto-More, Ukoha, & Rustagi, 2010; Lagesen, 2008; Larsen & Stubbs, 2005) have established the importance of having female teachers in careers related to computer science to break stereotypes about the masculinity of the discipline and attract more women to the field. In this regard, the School of Informatics can make efforts to achieve better gender parity among its faculty staff, providing a more heterogeneous and woman-friendly learning environment.

IT Programs at Aalborg University

The IT programs in Denmark are listed on the Futurepeople.dk website. The site is built and maintained as a cooperation among all the Danish universities and serviced by IT-Vest, which has information on all IT programs at the eight Danish universities, which are all public research universities and can be listed as follows: AAU, Aarhus University, Copenhagen Business School, the Danish Technical University, the IT-University in Copenhagen, Roskilde University, and Southern Denmark University. Overall, 3,831[5] students enrolled in a bachelor's program in IT in 2019 in Denmark. Among the universities, AAU is the biggest IT university, offering 23 different IT programs at the BA level, enrolling 752 students at the bachelor level, and 24 different IT programs at the master's level, with 683 students enrolling in 2019. In percentages, there has been a growth of 280% since 2010, but as we have seen above, there are still relatively few students enrolled in the IT programs compared with the numbers at UNA.

At the graduate level (master's), the enrollment of students has progressed positively in numbers from 238 in 2010 to 683 in 2019. In percentages, there has been a growth of 280%. The distribution of gender has also progressed positively in the period of 2010–2019. In 2010, only 34 (14.3%) female students and 204 male students were enrolled in a master's program in IT. In 2019, these numbers had risen to 236 (34.6%) female students and 447 male students enrolling in a master's degree. The highest percentage of female students relative to male students enrolling in the master's programs was in 2015/16, when 35.5% were female students (215 in real numbers). In real numbers, the biggest enrollment was in 2019, with 683 students divided into 236 females and 447 males.

AAU has IT programs in all faculties. Not surprisingly, the most programs are in TECH and ENG, with 12 at the bachelor level and 18 at the master's level; however, humanities are also well represented, with two programs at the bachelor level and five at the master's level.

IT-related bachelor programs at AAU

[5] The number is bigger as data from Roskilde University are missing.

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Table 7 presents the enrollment in the different IT programs at the BA level. The programs are listed under the faculty they belong to. The data shows the average numbers and percentages based on an accumulation of data for the period of 2009-2019. When presenting the data, we also look at the tendencies over the years based on our full datasets.

The distribution of gender is highly diverse in the different programs. Six programs are extremely divided, with predominantly male enrollment (more than 90%). These programs are found in science or tech. Two of the programs, Computer Science (BSc) and Software (BSc), are among the four biggest IT programs at AAU, those with most students. The other programs—Computer Engineering (BSc), Electronic Engineering and IT (BSc), Electronics (B.Eng), and Robotics (BSc)—are all tech programs. Some of these programs have as an average below 5% female enrollment.

When it comes to “very divided” bachelor programs with 70–89% domination by one sex, we find eight programs, with seven having predominantly male enrollment; these are as follows: Informatics (BSc); Information Technology (BSc); Interaction Design (BSc); Medialogy (BSc); Applied Industrial Electronics, (BSc); and IT, Communication and New Media (BSc)[6] in SCIENCE or TECH. Moreover, one program (the only IT program at the BA level) in the Faculty of Social Science (SOC)—Innovation and e-Government (BSc)[7]—also exhibited predominantly male. Finally, one of the “very divided” programs, Communication and Digital Media (BA) under HUM, was predominantly attended by females.

When it comes to the “less divided” category, we find two programs, both predominantly attended by women. One is Art and Technology (BA) under HUM, and the other is Biomedical Engineering and Informatics (BSc)[8] in MED. Finally, one program in Engineering Psychology (BSc) in TECH has an equal gender balance of 45–55%.

At the bachelor level, the IT programs at AAU are highly gendered; this is the case with 14 out of 17 programs. Thirteen of these programs are dominated by men, while the other is dominated by women.

Table 7 Enrollments in IT programs (Bachelor) and Graduates (Only Women) at AAU (Summarized for 2009–2019; Clickview, 2019)

Enrollments (bachelor)							**Graduates (bachelor)**	
Program	**Female**		**Male**		**Total**		**Female**	
HUM	N	%	N	%	N	%	N	%
Art and Technology (BA)	296	69.3	131	30.7	427	100	14	82.4
Communication and Digital Media (BA)	1,870	70.1	798	29.9	2,668	100	1,249	67.7
SCIENCE								
Computer Science (BSc)	40	5.6	674	94.4	714	100	15	5.0
Informatics (BSc)	31	14.6	182	85.4	213	100	7	14.3
Information Technology (BSc)	51	12.3	364	87.7	415	100	11	5.7
Interaction Design (BSc)	77	30.0	180	70.0	257	100	29	36.7
Medialogy (BSc)	484	18.6	2,118	81.4	2,602	100	171	16.6
SOC								

[6] IT, Communication, and New Media (BSc): Intake of students for 2010–2018.
[7] Innovation and e-Government (BSc): Intake of students for 2014–2019.
[8] Biomedical Engineering and Informatics (BSc) Intake of students for 2012–2019.

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Enrollments (bachelor)							**Graduates (bachelor)**	
Program	**Female**		**Male**		**Total**		**Female**	
Innovation and e-Government (BSc)[9]	15	17.2	72	82.8	87	100	0	0.0
MED								
Biomedical Engineering and Informatics (BSc)[10]	211	56.6	162	43.4	373	100	100	44.2
TECH								
Applied Industrial Electronics (BSc)	14	11.0	113	89.0	127[11]	100	0	0.0
Computer Engineering (BSc)	4	2.9	135	97.1	139	100	1	2.0
Electronic Engineering and IT (BSc)	17	3.4	482	96.6	499	100	15	3.8
Electronics (B. Eng)	8	4.8	160	95.2	168	100	0	0
Engineering Psychology (BSc)	111	47.4	123	52.6	234	100	55	47.0
IT, Communication, and New Media (BSc)[12]	61	15.2	340	84.8	401	100	16	11.2
Robotics (BSc [13])	29	8.3	322	91.7	351	100	12	12.5
Software (BSc)	68	5.5	1,168	94.5	1,236	100	18	3.8
TOTAL	**3,387**	**31%**	**7,524**	**69%**	**10,911**	**100**	**1,713 out of 5,111 (all)**	**33.5%**

IT-related master's programs[14] at AAU

At the master's level, the programs are also gendered. Fifteen programs out of 24 programs are enrolled in by predominantly one sex, with more than 70% of the enrollment. Fourteen of the programs are dominated by males, while one program—a master's in IT, Experience Design in HUM—is predominantly populated by women. However, compared with the bachelor's level, more programs have a more balanced profile: Information Architecture; Information Studies—Human-Centered Informatics in HUM; Biomedical Engineering and Informatics, TECH in the Faculty of Engineering (bachelor program in Med); and Engineering Psychology in the Faculty of Engineering. Moreover, two other programs are also very close to being balanced equally, that is, Interactive Digital Media under HUM and IT Design and Application Development under TECH.

When it comes to the extremely divided programs, Computer Science and Informatics in TECH—with 96.9% and 93.3% male populations, respectively—stick out. This is also the case with the programs in Communication Technology[15] (100%); Control and Automation (94.4%); Networks and Distributed Systems (91.3%); Signal Processing and Acoustics[16] (94.9%); and Software (95.8%), which show extreme predomination of males.

[9] Innovation and e-Government (BSc): Intake of students for 2014–2019.
[10] Biomedical Engineering and Informatics (BSc): Intake of students for 2012–2019.
[11] Applied Industrial Electronics (BSc): Intake of students for 2012–2019.
[12] IT, Communication, and New Media (BSc): Intake of students for 2010–2018.
[13] Robotics (BSc): Intake of students for 2014–2019.
[14] In this section, we are only presenting data about the ordinary academic IT master's program. There are also several master's IT programs for professionals.
[15] Program started intake in 2019.
[16] Program started intake in 2011.

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Table 8 *Enrollments in IT Programs (Master's) and Graduates (Only Women) at AAU (Summarized for 2009–2019; Clickview, 2019)*

Enrollments (master's)							**Graduates (master's)**	
PROGRAM	**Female**		**Male**		**Total**		**Female**	
	N	%	N	%	N	%	N	%
HUM								
Information Architecture	79	52.7	71	47.3	150	100.0	52	48.6
Information Studies—Human-Centered Informatics	141	49.3	145	50.7	286	100.0	78	50.0
Information Technology, Experience Design	198	71.2	80	28.8	278	100.0	135	71.8
Information Technology, Specializing in ICT, Learning, and Organizational Change[17]	309	59.9	207	40.1	516	100.0	177	60.4
Interactive Digital Media	193	42.3	263	57.7	456	100.0	144	41.0
SCIENCE								
Computer Science	8	3.1	248	96.9	256	100.0	7	3.3
Computer Science (IT)	16	10.7	133	89.3	149	100.0	5	6.8
IT Design and Application Development	77	44.0	98	56.0	175	100.0	28	35.9
Informatics	3	6.7	42	93.3	45	100.0	4	8.7
Interaction Design[18]	25	36.8	43	63.2	68	100.0	4	33.3
Medialogy	113	15.4	619	84.6	732	100.0	78	16.4
Service Systems Design	154	68.4	71	31.6	225	100.0	76	71.7
SOC								
IT Management	117	26.4	327	73.6	444	100.0	68	24.8
TECH								
Biomedical Engineering and Informatics	116	45.3	140	54.7	256	100.0	101	41.9
Communication Technology[19]	.	.	17	100.0	17	100.0		
Control and Automation	11	5.6	187	94.4	198	100.0	5	4.4
Engineering Psychology	56	45.5	67	54.5	123	100.0	36	42.4
Innovative Communication Technologies and Entrepreneurship	43	18.1	194	81.9	237	100.0	33	15.8
Networks and Distributed Systems	18	8.7	189	91.3	207	100.0	1	1.9
Robotics[20]	7	22.6	24	77.4	31	100.0		
Signal Processing and Acoustics[21]	5	5.1	93	94.9	98	100.0	18	9.0
Software	20	4.2	451	95.8	471	100.0	12	3.8
Vision, Graphics, and Interactive Systems[22]	16	13.7	101	86.3	117	100.0	12	14.6
Wireless Communication Systems[23]	7	11.5	54	88.5	61	100.0	7	15.6
TOTAL	**1,732**	**31%**	**3,864**	**69%**	**5,596**	**100**	**1,081 out of**	**29.0**

[17] For 2010–2019.
[18] For 2017–2019.
[19] Program started intake in 2019.
[20] Program started intake in 2019.
[21] Program started intake in 2011.
[22] Program started intake in 2011.
[23] Program ran 2011–2018.

Enrollments (master's)							**Graduates (master's)**	
PROGRAM	**Female**		**Male**		**Total**		**Female**	
	N	%	N	%	N	%	N	%
							3,729 (all)	

Table 9. Females (Summarized for 2009–2019) as Number and Percentage of All Enrolled in the IT Programs at ENG and TECH and Females Graduates (QlickView, 2019)

IT programs	**Females enrolled**	**All**	**% all**	**Females graduated**	**All**	**% all**
SCIENCE+TECH (bachelor)	895	7,356	12.1	350	3,244	10.8
SCIENCE+TECH (masters)	695	3,466	20.0	427	2,634	16.2
Total	1,590	10,822	14.7	777	5,878	13.2

It can be concluded that, when we compare the general average, there is a male predominance in most programs (13 out of 17 programs at the bachelor level; 17 out of 24 programs at the master's level), and as Tables 7 and 8 show, 13 programs (bachelor's and master's) exhibit an extreme predominance of males. However, there are also a few programs with a predominance of women, comprising 6 out of 41 programs. One of these programs is the bachelor program on Communication and Digital Media, which is the biggest IT program at the university. This program has a very divided profile, with a predominance of women. There is a weak tendency toward more equal participation in the IT programs at the master's level.

It is interesting to note that the programs that have a better female participation or balanced female participation can either be characterized as "soft technology programs" or IT programs founded in a humanistic approach. The programs Engineering Psychology (BSc, MSc), Biomedical Engineering and Informatics (BSc),[24] and Service System Design are examples of soft technology that involves human factors and facilitates human flexibility and initiatives (Jin, 2012). Soft technology emphasizes human needs rather than technology proper. In addition, the IT programs based in a humanistic approach have a balanced or predominance of female participation. Examples are Art and Technology (BA); Communication and Digital Media (bachelor); Information Architecture; Information Studies; Information Technology, Specializing in ICT; Learning and Organizational Change;[25] and Information Technology, Experience Design (master's level).

It is noteworthy that all the faculties except the Faculty of Social Sciences have at least one IT program with a balanced enrollment or female predominance. Humanities have six IT programs, while TECH and ENG have three programs and MED has one program. Thus, although there is a strong bias in all faculties except HUM and MED toward a predominance of males in the IT programs, the examples also demonstrate the ability to break the vicious circle. Finally, it is worth recognizing that some of the traditional core IT programs, such as computer science and software, have extreme domination by males.

Comparing the IT Programs at UNA and AAU

When comparing data from both the universities, there are some aspects that attract attention: UNA has three programs at the bachelor's level and four at the master's level, for a total of seven IT-related programs.

[24] Biomedical Engineering and Informatics (BSc): Intake of students for 2012–2019.
[25] For 2010–2019.

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AAU has 17 bachelor programs and 24 master's programs, for a total of 41 IT-related programs. It is evident that there is a diversity and specialization of programs in AAU that does not exist in UNA.

In the 2010–2018 period, 23,621 students were enrolled in UNA IT programs, while in AAU, in the 2010–2019 period, only 16,507 students were enrolled in the IT programs. That is, there were more students in IT careers at UNA in a period of 9 years than there were in AAU in a period of 10 years. However, when comparing the number of graduates, 3,970 students graduated from UNA in the period, versus 8,840 graduating from AAU.

In both universities, on average, the predominance is masculine (78% in UNA, 69% in AAU); however, in AAU, there are more female-dominated careers. In addition, in AAU, there are 13 programs considered "extremely divided"—with a gender gap greater than 90%—while in UNA, no program is classified in this category. When we only compare tech/science IT programs between UNA and AAU, AAU has fewer females, at 14.7%, against 22.0% in UNA. At both universities, the IT programs with a greater female predominance are those that have a more "soft technology"–oriented approach and/or a humanistic foundation.

DISCUSSION

Despite decades of progress toward equality, women remain underrepresented in some labor sectors, such as the IT sector, which is currently decisive in determining the productivity and competitiveness of a country. The gap between men and women who study and work in technology is not only unfair in social and economic welfare terms, but it also means that the technological products and services that are being developed, in a society increasingly influenced by technology, are considering the perspectives and needs of only half the population. In addition, some studies have indicated that women, more than men, consider that an important factor in their career choice is to feel that the work they do helps make the world a better place. Studying an IT-related career and working in this sector can provide women with a way to do it, since technology has the potential to make a big difference in societies around the world, providing significant improvements in people's lives.

In this global context, the interest of this chapter was to analyze the female representation in the IT programs of two state universities in two countries that have a long tradition of supporting gender equity and equality, Denmark and Costa Rica. The analysis of the information shows that both countries have signed international conventions that promote the right to equality and non-discrimination of any kind, thereby recognizing human diversity. In addition, both countries have enacted laws related to these principles and created institutions and mechanisms to prevent or report violations. However, in both countries, the rates of female participation in the workforce are lower than those of men. It is interesting to note that this situation arises even though the percentage of enrollment in tertiary education favors female in both countries. This means that, although Danish and Costa Rican women have a higher educational profile than men do, their level of education does not become a vehicle that guarantees their participation in the country's economy. In addition, in both countries, women face similar barriers, such as lower wages and occupational segmentation patterns, and in general, men earn better wages than women do, even though women have a higher educational level compared with men.

Not only is it important to increase the participation of women in the workforce, but it is also vital for countries' productivity and competitiveness to increase the presence of women in jobs that will be at the forefront of emerging economies and that already exhibit significant gender segregation. The index "Information and Communication Technologies, % of Achievement" (World Economic Forum, 2019), which shows the percentage of men/women graduating from tertiary education in IT programs, shows

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critical data for both Costa Rica (female: 1.85%, male: 11.65%) and Denmark (female: 2.03%, male: 8.29%). The numbers indicate that it is urgent for both countries to establish effective strategies to close gender gaps in the IT sector, which will contribute to producing a greater number of professionals in these areas.

At the level of state universities, technically, women and men are equal in the academic world, women are free to enter the fields of research and education that interest them, and university policies prohibit discrimination. However, despite this formal equality, universities are still characterized by numerous patterns of gender segregation that can be largely attributed to gender mechanisms. Both universities, the UNA in Costa Rica and the AAU in Denmark, are committed to equal opportunities without distinction of any kind. In this sense, both universities foster a university culture free of discrimination and gender marginalization, and they have established institutional policies and actions that seek to influence the organization and management of the university and its contribution to social justice and sustainable human development in the country.

Regarding numbers, we can compare the two universities in terms of the composition of the staff, their positions in the university, and the enrollment of students. In UNA, women represent 50% of university staff, so there is a practical numerical parity. In AAU, the numbers are more uneven. In all positions, men are better represented than women; especially in the permanent positions as associate professors, men dominate at 70%, while only 30% of associate professors are women. For the distribution of gender between top and middle management (rectors, vice-rectors, deans, school directors, and so on), in UNA, female representation is 44% and male representation is 56%. In AAU, the female representation in these positions is 29% and the male representation is 71%. In this respect, UNA has a better gender distribution than AAU does. This situation in both universities mirrors the national situation of both countries regarding the participation of women in positions of power and decision making.

In both universities, the faculty staff with the highest academic categories are predominantly male. In UNA, of the total number of academics who hold the position of full professors, 35% are women and 65% are men. In AAU, the underrepresentation of women is even bigger, with only 17% women and 83% men as full professors. In both universities, women encounter challenges to reach the higher academic positions.

Regarding students, in UNA, there is a clear trend in enrollment, with more women (55%) than men (45%) each year. In AAU, there is a more equal trend at the master's level, with 48.2% men and 51.8% women enrolling, while at the bachelor level, there is a greater enrollment of men (54%).

If we analyze the information related to IT programs, we see that there is a significantly different pattern regarding equality in both universities. UNA has a total of seven IT-related programs, while AAU has 41 IT-related programs. IT programs in UNA generally have a more traditional approach to the discipline, while in AAU, there is a diversity and specialization of programs that relate to other disciplines, such as communication, psychology, design, and art, in more innovative ways. In both universities, on average, the predominance is masculine (78% in UNA, 69% in AAU, but 86.3% in AAU if we compare tech/science IT programs); however, in AAU, there are more female-dominated careers. In addition, in AAU, there are 13 programs in tech/science that are considered "extremely divided"—with a gender gap greater than 90%; in UNA, there is no program in this category. Thus, in the comparison between the traditional IT programs, AAU seems to have even bigger challenges regarding equality than UNA does.

In both universities, the IT programs that have a greater female attendance or predominance are those that have a "soft technology"–oriented approach and/or a humanistic foundation. This is in line with a previous

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study (Jin, 2012). Soft technology emphasizes human needs rather than technology proper, involves human factors, and facilitates human flexibility and initiatives. Examples of these programs are found both in UNA and AAU, and in all cases, the women predominate or have equal participation. Further, there are several programs at AAU that are founded in the humanities; all have either a female predominance or equal attendance. Despite the equality initiatives at both institutions, it seems as if more radical changes are needed to change the career patterns regarding ICT.

Addressing gender issues in universities requires going beyond knowing the statistics of female and male participation in the different action spheres. It is necessary to raise awareness about prejudices and barriers, understand and adapt policies and practices to meet the needs of women and men in all areas and at all levels, and address the structural and power problems that tend to maintain inequalities. In this last respect, both universities have great scope for improvements.

"Fixing" the Women

In general, the perspective of this chapter is not that women have deficits regarding ICT; rather, the ICT business, ICT careers, and not least, the IT programs at the universities need to change for women to engage in them. This will allow companies and institutions to attract more qualified people, women to gain access to many new careers and promotion opportunities, and especially, as ICT is changing society and all careers dramatically, more women and more diversity to be included in this transformation. However, there is an issue where the "fix the women" approach may be relevant, and this is related to girls' self-esteem when it comes to ICT. Although there is no significant difference between boys' and girls' competences (secondary school), when it comes to basic use of IT (including out of school)—as opposed to advanced use, where there is a very small group of engaged boys— there is a significant gender difference regarding self-esteem for the girls in relation to the boys (8 points). This difference is evident even though girls on average achieve better scores than boys in computer and information competences and equal boys in computational thinking in schools' ICT programs (Bundsgaard, Bindslev, Caeli, Pettersson, & Rusmann, 2019). The same patterns have also been found in the study of the university students in the IT programs in Costa Rica. Here, female students express lower self-esteem regarding doing programing compared with males, even though they achieve better scores on exams (Mora-Rivera et al., 2017). Finally, the same tendency can be found in the job application process, where women do not apply if they do not fulfill all the requirements for a position, while their male counterparts have more positive self-esteem and do not hesitate to apply even if they only fulfill a few of the requirements (Danish Magister Association, personal communication 27th of November, 2019).

The initiatives from AAU to offer ICT camps for female high school students, as well as the screening programs for bias, can be seen as relevant to ensuring girls and women feel invited and not excluded. However, the data from this chapter raises the question of whether these initiatives are sufficient. The approach of "fixing" the organization may also be needed.

"Fixing" the Curriculums

Instead of reading the numbers of women's participation in the IT programs above as if few female students enroll in IT programs, the statistics document that an higher or equal enrollment of women in the IT programs that are founded in the humanities and/or that women orient themselves toward use practices and "soft" technologies. Therefore, the authors ask: What will happen if we change the perspective? Instead of focusing on women as the problem and how to get more women to enter traditional IT programs in the faculties of technical and natural sciences, what would happen if we took elements of these traditional IT programs and integrated them into the programs of humanities in which women are already participating?

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What if we add more advanced IT elements, such as data mining, artificial intelligence, and data analysis? Another approach in the same line would be to ask: What would happen if the IT programs were changed radically in their constitution, so the technical and scientific approach is integrated into a critical and human-centered approach?

It could be argued that this is similar to the idea of Science, Technology, Engineering, Arts, Math (STEAM), where arts is built and integrated into STEM (Feldman, 2015; Riley, 2018). According to Feldman (2015 para. 3), "'STEAM' takes the standard STEM formulation (science, technology, engineering, and math) and adds an A for arts. And, well, it seems to be gaining steam" It inspires students' imagination and innovation and adds creative thinking and design skills to the STEM projects. As Riley (2018) noted "STEAM is intentional about connecting the arts in and through the STEM areas. It's not just about ´making the product look pretty'" (Riley, 2018 para. 4). Instead she argues, that the arts should be an integral part of the work as a whole – both arts as a field and arts as a skill.
As Feldman (2015) argued:

> *This is not about cultivating more artists or diluting STEM—it's about creating STEM students who think creatively and remain engaged in their learning. True, not everyone will want to or should go into STEM, but the point is to reach those who would contribute in STEM fields but may be turned off by a difficult math class, a boring biology teacher, or not seeing people like them represented in those fields. How many potential scientists are we missing because we continue to push the same STEM curriculum even as money pours in from STEM grants? How many who aren't part of the 'priesthood' of scientists still deserve to be given another chance to be successful in STEM?(Feldman, 2015 para. 9)*

The data in this chapter support the idea of STEAM as a means to develop the curriculum from the traditional IT curriculums and change the culture to attract more women to the traditional STEM areas. Some of the programs at AAU in ENG and TECH have already changed in this direction, and they have done so with success when it comes to attracting more women to some programs. However, the question is as follows: Is this approach radical enough to attract more women to the traditional STEM areas? STEAM may be criticized for adding art as a kind of appendix to the traditional and disciplinary IT-engineering and IT-science programs, although Riley (2018) especially argued for integration. Therefore, an even more radical approach would be to also base the IT programs in the arts and humanities and reactivate the discussion of the philosophical foundation, methodological approaches, and use practice at the center of the programs. The strategy would be to develop transdisciplinary approaches to the ICT programs based in the humanities, sciences and tech to transform the philosophical and methodological foundation, and to focus the programs and development on enhancing the humans' use practices (understood as gendered practices). This could change the programs radically, and supported by the data in this chapter, attract much more female students. Further, in both UNA and AAU—albeit most distinctly in AAU—the underrepresentation of women as full professors and middle- and top leaders should be "fixed" to provide diversity at the highest level of academia and develop a diverse curriculum and culture that will be attractive to both genders.

CONCLUSION

The Global Gender Gap Report of the WEF 2020 (WEF, 2019) revealed that 68.6% of the gender gap has been closed worldwide. The survey predicts that it will take 95 years to achieve general gender parity and 257 years to achieve total equality in the workplace due to the slow rate of progress experienced in this regard during the period of 2006–2020. However, despite the progress made, more actions are needed to address gender inequality. This is especially important at a time when workplaces are changing rapidly due to technological advances in areas like artificial intelligence, big data analysis, cloud computing, blockchain, and so on. It has been established that the lack of gender diversity in the IT sector entails a

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significant opportunity cost. The IT sector needs to innovate quickly to expand its workforce. The demand for advanced IT and programming skills will grow by up to 90% over the next 15 years (McKinsey Global Institute, 2018). An expected shortage of technological resources in companies is already reported. To stay ahead, the technology sector needs to rapidly expand its human resources by investing and attracting historically underutilized talents, especially those of women.

Aware of this dramatic situation, at the beginning of this chapter, we asked two questions: What is the rate of women's participation in different kinds of university ICT programs? How can women's participation in IT programs be improved at the university level? We sought to answer these questions using two case studies—UNA in Costa Rica and AAU in Denmark. Rather than establishing causality between policies, structural, national, and institutional characteristics on the one hand and women's participation in university IT programs on the other, the goal of this chapter was to identify patterns in our two case studies.

Regarding the first question, in our two case studies of Costa Rica and Denmark, women remain underrepresented in the IT sector. In Costa Rica, only 1.85% of people who graduate from the ICT programs in tertiary education are women. For Denmark, this percentage rises to 2.03% (WEF, 2019), but it is still greatly uneven in both countries. Specifically, at the level of the universities studied, UNA has a total of 7 IT-related programs, while AAU has 41 IT-related programs. IT programs in UNA generally have a more traditional approach to the discipline, while in AAU, there is a diversity and specialization of programs that allows them to relate to other disciplines, such as communication, psychology, design, and art, in more innovative ways. In a period of 9 years at UNA (2010–2018), a total of 23,621 students enrolled in the IT programs, while in AAU (2010–2019), 16,507 students enrolled in IT programs. This implies that, despite its small number of study programs, UNA has managed to attract more students than AAU has. In both universities, on average, the male predominance is alarming (78% in UNA, 69% in AAU); however, in AAU, there are more female-dominated careers. In addition, there are 13 programs in AAU that have a radical gender gap of over 90%, while in UNA, no program reaches this percentage. One aspect that catches our attention is that, in both universities, the IT programs that have a greater female predominance are those that have a more "soft technology"–oriented approach and/or are founded in humanities. This is consistent with the female tendency to choose careers where the work activity allows them to contribute to making the world a better place (Ashcraft et al., 2016). In sum, the literature has established that the gender imbalance in technology represents a lost opportunity not only for women and society but also for the economy of countries and businesses. If half of the population is overlooked as a source of technological talent, countries reduce their potential to increase productivity and national competitiveness. If countries can attract more women to better paid labor sectors, such as technology, this will help reduce the gender pay gap and increase women's economic empowerment for the benefit of the economy and society. In this regard, universities have a responsibility to create strategies that allow them to attract and retain more women in IT-related careers in such a way that they contribute to the social and economic benefit of their countries.

The results for the first question led to some reflections on the second research question. In popular terms there are two main approaches to improving women's participation in IT programs at the university level—"fixing" the women, which sees the women's deficits as the explanation for their lack of participation, and "fixing" the organization, which finds its explanation for the disparity in complex structures that reproduce a preexisting inequality. This chapter primarily leans toward fixing the organizations, with a focus on the IT programs and curriculum. Based on a reading of which IT programs have a predominance or equal presence of women, the chapter suggests reflecting on the three following approaches: (1) adding some advanced elements, such as programming, artificial intelligence, big data analysis, cloud computing, and blockchain, into the IT programs founded in Humanities; (2) taking a closer look at STEAM, especially on

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how to integrate elements from arts, such as design, into STEM educational programs (Feldman, 2015; Riley, 2018); and as the most radical suggestion, (3) investigating and rethinking the IT programs from a humanities perspective and establishing AH-STEM by basing the IT programs in an arts and humanistic approach, as well as discussing the resulting discipline's foundation and new methodologies, along with a human-centered use practice.

Finally, for both UNA and AAU—albeit most distinctly for AAU—the underrepresentation of women as full professors and in the leadership of the universities should be "fixed." It is not adequate that countries that are in a privileged group in the Global Gender Gap Index (WEF, 2019) cannot provide diversity at the highest level of academia and in the overall leadership of universities.

References

Ashcraft, C., McLain, B., & Eger, E. (2016). *Women in tech: The facts*. National Center for Women & Technology (NCWIT).
Barker, L., & Cohoon, J. M. (2015). How Do You Retain Women through Inclusive Pedagogy? *Computer Science Education*, *12*, 16.
Beckhusen, J. (2016). *Occupations in Information Technology.* US Department of Commerce, Economics and Statistics Administration, US Census Bureau.
Beyer, S. (2008). Predictors of female and male computer science students' grades. *Journal of Women and Minorities in Science and Engineering*, *14*(4).
Bundsgaard, J., Bindslev, S., Caeli, E. N., Pettersson, M., & Rusmann, A. (2019). *Kapitel 6 Køn og it | Danske elevers teknologiforståelse*. Retrieved 29th of November 2019. https://icils2018.au.dk/koenogit.html#hvordan-kan-vi-skabe-en-bedre-balance
Burkinshaw, P., & White, K. (2017). Fixing the Women or Fixing Universities: Women in HE Leadership. *Administrative Sciences (2076-3387)*, *7*(3), 30. buh.
Buzzetto-More, N. A., Ukoha, O., & Rustagi, N. (2010). Unlocking the barriers to women and minorities in computer science and information systems studies: Results from a multi-methodological study conducted at two minority serving institutions. *Journal of Information Technology Education: Research*, *9*(1), 115–131.
Clickview. (2019). *Dataset* [Data-set]. Aalborg University.
CONARE. (2019). *Estadísticas matrícula y graduación en carreras relacionadas con ciencias de la computación. Universidades Estatales.* [Personal communication].
Conare. (2019). *SIESUE, Sistema de Información de la Educación Superior Universitaria Estatal*. http://siesue.conare.ac.cr/docencia/indicadores-objetivo-actividad.html
Council of Europe. (n.d.). *What is gender mainstreaming?* Council of Europe. Retrieved 19 December 2019, from https://www.coe.int/en/web/genderequality/what-is-gender-mainstreaming
European Commission. (2015). *European research area (ERA)* [Text]. European Commission - European Commission. Retrieved 19 December 2019 from https://ec.europa.eu/info/research-and-innovation/strategy/era_en
European Commission, & Directorate-General for Research and Innovation. (2016). *She figures 2015.* Publications Office. Retrieved 19 December 2019, from http://bookshop.europa.eu/uri?target=EUB:NOTICE:KI0415386:EN:HTML

European Institution for Gender Equality. (n.d.). *What is gender mainstreaming?* Retrieved 24 December 2019, from https://eige.europa.eu/gender-mainstreaming/what-is-gender-mainstreaming

Faber, S. T., Gemzøe, A. S., & Nielsen, H. P. (2017). *Ligestillings- og diversitetsindsatser på AAU. Perspektiver, tilgange og tendenser*. Aalborg Universitet.

Feldman, A. (2015, June 16). *Why We Need to Put the Arts Into STEM Education*. Slate Magazine. Retrieved 31 December 2019, from https://slate.com/technology/2015/06/steam-vs-stem-why-we-need-to-put-the-arts-into-stem-education.html

Jin, Z. (2002). Soft technology: The essential of innovation. *Futures Research Quarterly*, *18*(2), 1–24.

Justitsministeriet. (1987). *Bekendtgørelse af lov om forbud mod forskelsbehandling på grund af race m.v. - Retsinformation.dk*. Retrieved 24 December 2019, from https://www.retsinformation.dk/forms/r0710.aspx?id=59249

Katz, S., Allbritton, D., Aronis, J., Wilson, C., & Soffa, M. (2006). Gender, achievement, and persistence in an undergraduate computer science program. *ACM SIGMIS Database*, *37*(4), 42–57. https://doi.org/10.1145/1185335.1185344

Kim, K. A., Fann, A. J., & Misa-Escalante, K. O. (2011). Engaging women in computer science and engineering: Promising practices for promoting gender equity in undergraduate research experiences. *ACM Transactions on Computing Education (TOCE)*, *11*(2), 8.

Ki-Moon, B. (2015). The Millennium Development Goals Report 2015. *United Nations Pubns*.

Lagesen, V. A. (2008). A cyberfeminist utopia? Perceptions of gender and computer science among Malaysian women computer science students and faculty. *Science, Technology, & Human Values*, *33*(1), 5–27.

Larsen, E. A., & Stubbs, M. L. (2005). Increasing diversity in computer science: Acknowledging, yet moving beyond, gender. *Journal of Women and Minorities in Science and Engineering*, *11*(2).

Ligestillingsudvalget. (2011, December). *Bilag 83: Materiale til 2020-samarbejdets foretræde*. Retrieved 24 December 2019, from https://www.ft.dk/samling/20111/almdel/LIU/bilag/83/1160933/index.htm

McKinsey Global Institute. (2018). *Skill shift automation and the future of the workforce*.

MICITT. (2017). *Política Nacional para la igualdad entre mujeres y hombres en la formación, el empleo y el disfrute de los productos de la Ciencia, Tecnología, las Telecomunicaciones y la Innovación 2018-2027.* Ministerio de Ciencia, Tecnología y Telecomunicaciones (MICITT).

Minister for Ligestilling. (2019). *Redegørelse/perspektiv- og handlingsplan 2019: Afgivet til Folketinget af minister for ligestilling den 28. februar 2019*. Minister for Ligestilling.

Bekendtgørelse af lov om ligestilling af kvinder og mænd1), Pub. L. No. LBK nr 1678 (2019). Retrieved 30 December 2019, from https://www.retsinformation.dk/Forms/R0710.aspx?id=160578

Mora-Rivera, S., Coto-Chotto, M., & Villalobos-Murillo, J. (2017). Participación de las mujeres en la carrera de Ingeniería Informática de la Universidad Nacional y su desempeño en los cursos de programación. *Revista Electrónica Educare*, *21*(1), 221–242.

Morgen, M. (2019). *Danmark ryger ned ad ligestillingsliste, men listen bygger på 'absurde resultater'*. Tjekdet. Retrieved 24 December 2019, from //www.mm.dk/tjekdet/artikel/danmark-ryger-ned-ad-ligestillingsliste-men-listen-bygger-paa-absurde-resultater

Final version of the chapter for publishing.
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Nager, A., & Atkinson, R. (2016). The Case for Improving US Computer Science Education. *NCSSS Journal*, *21*(1), 18–19.
Paloheimo, A., & Stenman, J. (2006). *Gender, communication and comfort level in higher level computer science education-Case study*. 13–18.
Parpart, J. L. (2014). Exploring the transformative potential of gender mainstreaming in international development institutions. *Journal of International Development*, *26*(3), 382–395.
Pischetola, M., & Dirckinck-Holmfeld, L. (Forthcoming). *Enactivism and Digital Learning Platforms*. Twelfth International Conference On Networked Learning, 18-20th of May, Kolding, Denmark. https://www.networkedlearning.aau.dk/
Powell, C., & Chang, A. M. (2016). Women in tech as a driver for growth in emerging economies. *Council on Foreign Relations*.
Programa Estado de la Nación. (2017). *Sexto Informe Estado de la Educación*. Conare.
Programa Estado de la Nación. (2018). *Informe Estado de la Nación 2018*. Conare.
Programa Estado de la Nación. (2019). *Séptimo Informe Estado de la Educación*. Conare.
Rambøll. (2018). *LIGESTILLINGSREDEGØRELSER 2017HOVEDRAPPORT*. UDENRIGSMINISTERIET/MINISTER FOR LIGESTILLING.
Riley, S. (2018, September 1). STEAM Careers for the 21st Century. *The Institute for Arts Integration and STEAM*. Retrieved 31 December 2019, from https://educationcloset.com/2018/09/01/steam-careers-for-the-21st-century/
Solórzano, A. (2018). *Discriminación salarial por motivo de género en Costa Rica*. Informe Estado de la Nación 2018, San José, Costa Rica.
Statistics Denmark. (2019). *Statistikbanken*. Retrieved 24 December 2019, from https://www.statistikbanken.dk/statbank5a/default.asp?w=1280
Stoilescu, D., & Egodawatte, G. (2010). Gender Differences in the Use of Computers, Programming, and Peer Interactions in Computer Science Classrooms. *Computer Science Education*, *20*(4), 283–300.
Sullivan, K., Byrne, J. R., Bresnihan, N., O’Sullivan, K., & Tangney, B. (2015). *CodePlus—Designing an after school computing programme for girls*. 1–5.
UDENRIGSMINISTERIET/MINISTER FOR LIGESTILLING. (2018). *Hovedrapport om måltal og politikker i statslige institutioner 2017*. UDENRIGSMINISTERIET/MINISTER FOR LIGESTILLING. Retrieved 24 December 2019, from https://mfvm.dk/fileadmin/user_upload/MFVM/Ligestilling/Andre_dokumenter/Hovedrapport_om_mltal_og_politikker_staten_2017.pdf
UNA. (2016). *Política para la igualdad y equidad de género en la Universidad Nacional y Plan de acción*. Instituto de Estudios de la Mujer. Universidad Nacional.
UNA Departamento de Registro. (2019). *Estadísticas Estudiantiles*. https://www.registro.una.ac.cr/see/
Universidad Nacional. (2019). *UNA transparente*. Retrieved 24 December 2019, from https://www.transparencia.una.ac.cr/
Vilner, T., & Zur, E. (2006). *Once she makes it, she is there: Gender differences in computer science study*. ACM.
Vitores, A., & Gil-Juárez, A. (2016). The trouble with ‘women in computing’: A critical examination of the deployment of research on the gender gap in computer science. *Journal of Gender Studies*, *25*(6), 666–680.

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Wilson, B. C. (2002). A study of factors promoting success in computer science including gender differences. *Computer Science Education*, *12*(1–2), 141–164.
World Economic Forum. (2019). *Global Gender Gap Report 2020*. World Economic Forum.