United Nations
Educational, Scientific and
Cultural Organization

Sustainable
Development
Goals

MEASURING GENDER EQUALITY IN SCIENCE AND ENGINEERING: THE SAGA TOOLKIT

Working Paper 2

STEM and Gender Advancement (SAGA)

United Nations
Educational, Scientific and
Cultural Organization

Sida

Sweden
Sverige

STEM and Gender Advancement (SAGA)

Improving Measurement and Policies
for Gender Equality in STEM

A Global UNESCO project, with the support of Sida

MEASURING GENDER EQUALITY IN SCIENCE AND ENGINEERING: THE SAGA TOOLKIT

Working Paper 2

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Acronyms and abbreviations

ASSAf	The Academy of Science of South-Africa
CDH	Careers of Doctorate Holders
CM	*Canberra Manual*
CONFEMEN	Conférence des ministères de l'Éducation des États et gouvernements de la Francophonie
EU	European Union
Eurostat	Statistical Office of the European Union
FM	*Frascati Manual*
FORD	Fields of Research and Experimental Development
FTE	Full-time equivalent
GAO	U.S. Government Accountability Office
GDRC	Gender dimension in research content
GEM	Global Entrepreneurship Monitor
GO-SPIN	Global Observatory of Science, Technology and Innovation Policy Instruments
GOV	Government
HAN	Harmonised Applicant Name
HC	Headcount
HE	Higher Education
HRST	Human resources in science and technology
IAC	InterAcademy Council
IAP	InterAcademy Partnership
ICILS	International Computer and Information Literacy Study
ICT	Information and communication technologies
IEA	International Association for the Evaluation of Education Achievement
ILO	International Labour Organization
ISCED	International Standard Classification of Education
ISCED-F	International Standard Classification of Education - fields of education and training
ISCO	International Standard Classification of Occupations
LAC	Latin American and the Caribbean
LDCs	Least developed countries
OECD	Organisation for Economic Co-operation and Development
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne
NGOs	Non-governmental organizations
PASEC	Programme d'analyse des systèmes éducatifs de la CONFEMEN
PISA	Programme for international student assessment
R&D	Research and experimental development
S&E	Science and engineering
S&T	Science and technology
SAGA	STEM and Gender Advancement
SACMEQ	The Southern and Eastern Africa Consortium for Monitoring Educational Quality

SDGs	Sustainable Development Goals
Sida	Swedish International Development Cooperation Agency
SIDS	Small islands developing states
STEM	Science, technology, engineering and mathematics
STEAM	Science, technology, engineering, arts and mathematicss
STI	Science technology and innovation
STI GOL	Science, Technology and Innovation Gender Objectives List
TIMSS	Trends in International Mathematics and Science Study
TVET	Technical and vocational education and training
UIS	UNESCO Institute for Statistics
UNESCO	United Nations Educational, Scientific and Cultural Organization
WIPO	World Intellectual Property Organisation


Women
Gender Equality
Indicators
Gender Gap
STEM
STI
Policy
Tools
Toolkit
Girls
Data
UNESCO
SAGA
Science
Sex-Disaggregated Data
Inform
Education
Country
Global
Research
Better
sources
Evaluate
Support
Level
Evidence Based
Instruments
Fields
Workforce
Career
National
Relate
Spin
Men
Set
Thus
Statistics
Different
Collect
Innovation
Technology
Provide
Report
Improve
Develop
Design
Capacity
Methodology
Drivers
Assess
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System
Box
Help
Lack
Goal
Key
UIS
Evidence
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Barriers
World
International
Participation
Increase
Agency
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Way
Full
Analysis
Identify
Critical
Decrease
Swedish

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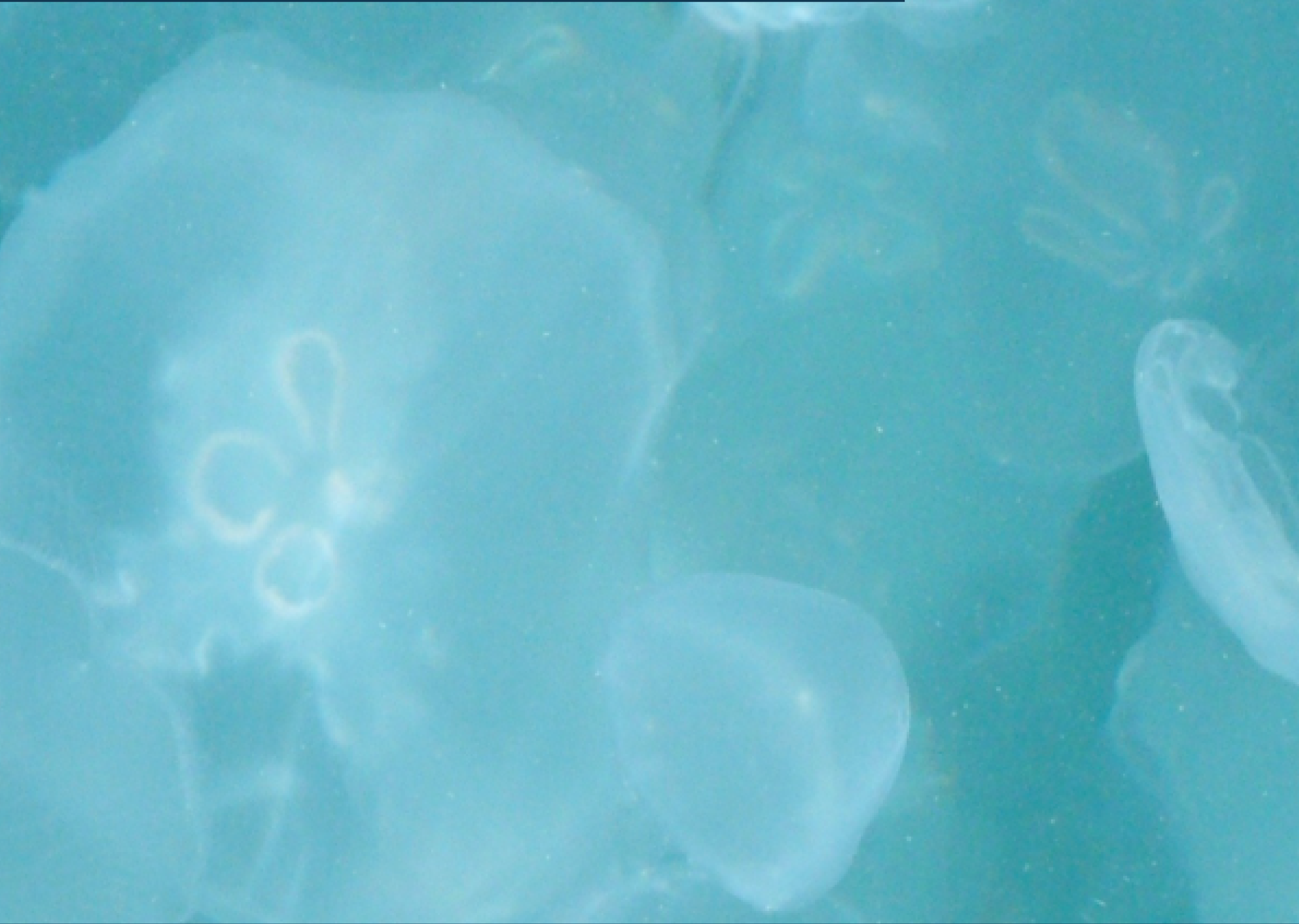
1. Introduction



The SAGA Toolkit sets out a conceptual and methodological framework to provide a series of tools to integrate, monitor and evaluate gender equality in STEM and assist in the design of gender-sensitive and evidence-based policies to strengthen the gender policy agenda.

1.1 Background

Measuring Gender Equality in Science and Engineering: the SAGA Toolkit is a product of SAGA (STEM and Gender Advancement),[1] a global UNESCO project supported by the Government of Sweden through the Swedish International Development Cooperation Agency (Sida). SAGA's main objective is to offer governments, policy-makers and other stakeholders a variety of tools to help decrease the current global gender gap in science, technology, engineering and mathematics (STEM) fields which varies across fields and exists at all levels of education and in research.[2] This goal is achieved using two approaches, namely, by an evaluation of policies affecting gender equality in STEM, and by the identification and design of indicators linked to science, technology and innovation (STI) policies, to enable evidence-based policy-making. Thus, the SAGA initiative will help to:

- build capacity for the collection of data on gender in STEM;
- improve the measurement and evaluation of women's and girls' situation in science;
- identify gaps in the policy mix and improve national STI policies related to gender, based on evidence;[3]
- reduce the gender gap in STEM at all levels of education and in research; and
- increase the visibility, participation and recognition of women's contributions in STEM.

The SAGA project contributes to the promotion of girls and women in STEM by offering tools and technical assistance to countries to attract and retain them in STEM fields. This will support directly the achievement of Sustainable Development Goals (SDGs), especially targets:

- **5.5:** Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life;
- **5.c:** Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels;
- **9.5:** Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending; and
- **17.18**: by 2020, enhance capacity building support to developing countries, including for for least developed countries (LDCs) and small islands developing states (SIDS), to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts.

By working towards these goals and harnessing women's full potential in STEM fields, countries will reach higher levels of development, increase their research output and build capacity, thereby reducing inequalities and knowledge gaps. This, in turn, will enable countries to achieve many other STI-based SDG targets.

1. For more information on the background of the project, visit SAGA's website http://www.unesco.org/new/en/saga.
2. The SAGA project is partnered with other initiatives that primarily focus on innovation, thus the main focus of the project is on STEM.
3. This also includes the integration of a gender dimension in research and innovation content.

Box 1: United Nations Sustainable Development Goals

In 2015, Member States adopted the 2030 Agenda for Sustainable Development and its 17 SDGs. Over the subsequent 15 years, countries are to mobilize efforts to end all forms of poverty, fight inequalities and tackle climate change, while ensuring that no one is left behind. (https://sustainabledevelopment.un.org/)

1 NO POVERTY

SDG 1

End poverty in all its forms everywhere

2 ZERO HUNGER

SDG 2

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

3 GOOD HEALTH AND WELL-BEING

SDG 3

Ensure healthy lives and promote well-being for all at all ages

4 QUALITY EDUCATION

SDG 4

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

5 GENDER EQUALITY

SDG 5

Achieve gender equality and empower all women and girls

6 CLEAN WATER AND SANITATION

SDG 6

Ensure availability and sustainable management of water and sanitation for all

7 AFFORDABLE AND CLEAN ENERGY

SDG 7

Ensure access to affordable, reliable, sustainable and modern energy for all

8 DECENT WORK AND ECONOMIC GROWTH

SDG 8

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

SDG 9

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

10 REDUCED INEQUALITIES

SDG 10

Reduce inequality within and among countries

Box 1: United Nations Sustainable Development Goals

SDG 11	Make cities and human settlements inclusive, safe, resilient and sustainable
SDG 12	Ensure sustainable consumption and production patterns
SDG 13	Take urgent action to combat climate change and its impacts
SDG 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
SDG 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
SDG 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
SDG 17	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

Source: https://sustainabledevelopment.un.org/

The SAGA project is implemented by the UNESCO Natural Sciences Sector in Paris and the UNESCO Institute for Statistics (UIS) in Montreal, Canada, in cooperation with several UNESCO field offices. The SAGA Steering Committee is comprised of an internal team who oversees and monitors the project's activities. The Steering Committee is supported by an Advisory Committee, composed of senior international experts in gender equality in STI policy and indicators from all regions of the world, to support and provide strategic input and advice in order for the project to reach its objectives. Other global and regional efforts addressing gender equality in STEM have joined forces with the SAGA project to help diffuse the SAGA initiative and inform widely at multiple levels as shown in Figure 1.

This Toolkit is part of SAGA's publication series, which makes SAGA's methodology and research tools publicly available for policy-makers, researchers, non-governmental organizations (NGOs), and other stakeholders. This publication series, used in capacity-building activities carried out across the world, consists of several working papers, each focusing on one of the specific tools of the project developed within the framework of project. These publications are available on SAGA's website.

Figure 1: SAGA Advisory Committee and partners

This document is part of the SAGA methodology on measuring and evaluating gender equality in science and engineering (S&E), which includes four working papers depicted in Figure 2:

- Working Paper 1: SAGA Science, Technology and Innovation Gender Objectives List (STI GOL);
- Working Paper 2: the SAGA Toolkit;
- Working Paper 3: SAGA Survey of Gender Equality in STI Policies and Instruments;
- Working Paper 4: SAGA Survey of Drivers and Barriers to Careers in Science and Engineering.

Figure 2: SAGA methodology scheme

1.2 Science, technology, engineering and mathematics, and gender equality

Despite the remarkable gains that women have made in education and the workforce over the past decades, progress has been uneven. There is currently a large imbalance in the participation of women in STEM fields compared to men, in particular at more advanced career levels. Moreover, although STEM fields are widely regarded as critical to national economies, so far most countries, industrialized or not, have not achieved gender equality in STEM. According to estimates by the UIS, women represent less than 30% of the R&D workforce worldwide.

The UNESCO report *Cracking the code: girls and women's education in STEM* points out that 'gender differences in STEM education participation at the expense of girls are already visible in early childhood care and education and become more visible at higher levels of education' (UNESCO, 2017, p. 11). In fact, existing data demonstrate that women are globally under-represented in fields of STEM, both in the number of graduates (especially at the Ph.D. level), and in research professions (see for example *UNESCO Science Report: Towards 2030* or the UIS

Box 2: UNESCO's earlier efforts to promote gender equality in STEM

Socioeconomic factors and gender-based discrimination still prevent girls and women from accessing equal opportunities to complete and benefit from an education of their choice. Furthermore, the low participation of women in STEM education and, consequently, STEM careers, remains a major concern. UNESCO plays a key role in taking up these issues and working to overcome gender disparities in the access to, influence over, and use of STEM. UNESCO has over 30 years of experience in studies on the role of women in science, the gender dimensions of policies related to the development and the application of STI for development.

In 1995 at the World Conference on Women and, again, in 1999 at the World Conference on Science for the Twenty-first Century: a New Commitment, the United Nations called for sex-disaggregated data in all areas of development, including in science and technology. Furthermore, UNESCO stressed how special efforts need to be made by governments, educational institutions, scientific communities, NGOs and civil society, with support from bilateral and international agencies, to ensure the full participation of women and girls in all aspects of science and technology.

In ***Sixty Years of Science at UNESCO 1945-2005*** Tapping at the Glass Ceiling. 'Women, natural sciences and UNESCO' (Petitjean, et al., 2006), Clair concluded that despite the messages from world conferences, progress towards gender equality remains slow.

UNESCO works towards providing strong role models for women and girls in science throughout the world, building capacities for women in STEM, as well as supporting and promoting the contributions of women to scientific knowledge generation and dissemination to advance sustainable development. For instance, since its creation in 1998, the UNESCO-L'Oréal For Women in Science partnership continues to be an outstanding vehicle to celebrate role models from all over the world and to support and inspire women and girls to engage in and pursue scientific careers, while networks such as the Organization for Women in Science for the Developing World serve to strengthen dialogue and lessons learned among women in science.

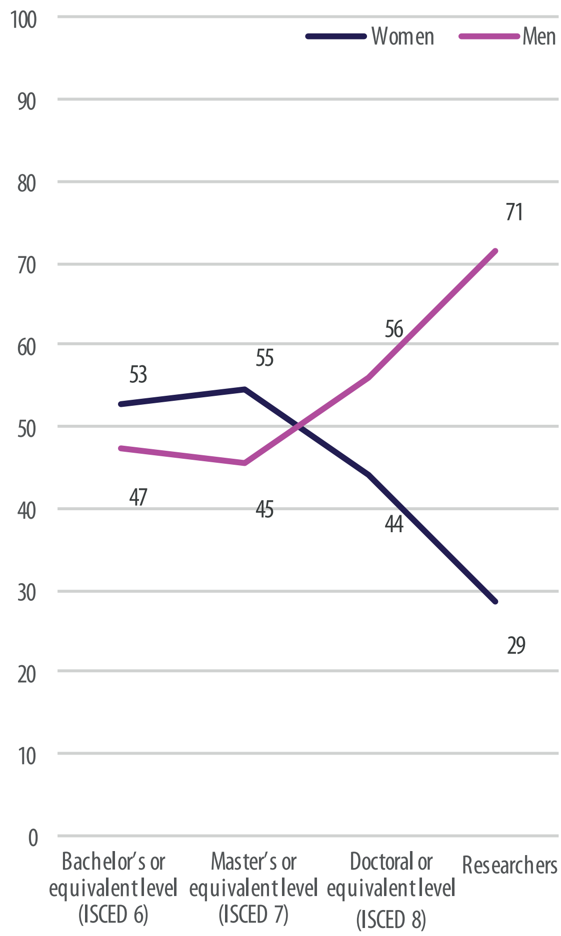
Furthermore, the UIS created STEM gender indicators in 2006 by going beyond regular research and experiment development (R&D) data broken down by sex, but lacked funds to continue thereafter. In 2007, UNESCO launched ***Gender Indicators in Science, Engineering and Technology: An Information Toolkit*** (Huyer & Westholm, 2007), aimed at providing a better understanding of the numbers and needs at stake in STEM fields, including quantitative and qualitative indicators for the participation of women and under-represented groups, especially in developing countries. That same year UNESCO also published ***Science, Technology and Gender: An International Report*** (UNESCO, 2007).

The SAGA project emerged from these efforts to create statistics on STEM and to provide support to advocate for gender equality in STI policies.

Women in Science visualisation), with gender gaps generally more apparent in disciplines such as mathematics, engineering and computer science.[4] The fifth edition of *She Figures*, the main source of pan-European comparable statistics on the state of gender equality in research and innovation, also shows evidence of the gap between women and men (European Commission, 2016).

The under-representation of women in STEM translates into the loss of a critical mass of talent, thoughts and ideas, which hinders countries from reaching their maximum development potential. The loss of women graduates in STEM during the transition to the S&E workforce, often illustrated using a scissor diagram (see Figure 3), represents a great challenge which needs to be better understood in order to address the situation appropriately.

Figure 3. Proportion of women and men graduates in tertiary education by programme level and those employed as researchers, 2014



Source: UNESCO Institute for Statistics (UIS)

4. Gaps between men and women in STEM fields vary from country to country due to the different sociocultural factors found across the world.

Furthermore, the way in which STEM data are predominantly collected renders women and the challenges they face in balancing social expectations and professional careers relatively invisible due to the general lack of sex-disaggregated data reported, and on drivers and barriers they face in STEM. The growing demand for cross-nationally comparable statistics on the participation of girls and women in STEM, and other relevant topics such as on the use of information and communication technologies (ICT) and the internet by girls and women, is slowly starting to be addressed. In order to improve countries' capacity in STEM and to achieve the SDGs of the United Nations' *Transforming our World: the 2030 Agenda for Sustainable Development*, gender equality in science must be prioritized and actively addressed through policies and programmes. In order to monitor and evaluate gender equality and to integrate gender aspects in policies, the SAGA Toolkit looks into and links two central aspects for addressing gender equality in STEM: policies, and indicators as evidence for policies in STI.

1.3 Science, technology and innovation policies towards gender equality

Public policies generally have an impact, conscious or not, on the gender dimension, frequently leading to inequalities between men and women and contributing indirectly to maintaining the gender gap. In recent years, numerous countries have implemented policy initiatives aimed at reaching gender equality by increasing women's participation in S&E careers. The gender imbalance in STEM, however, is a consequence of many different social and cultural factors including long-term implicit or explicit STI policies and practices at various levels, inside and outside the STI system (*inter alia* by governments, funding agencies, higher education institutions, research centres), which have frequently neglected gender equality.

To address issues which have not been studied yet at the global scale, there is a need to collect evidence to evaluate and better understand current STI policy plans and instruments by using and creating policy-relevant indicators and information related to all aspects of women in STEM. Some questions which remain largely unanswered include, for example:

- How can cultural bias be overcome?
- Does having role models lead to measurable increases in the number of women and girls studying STEM?
- Does greater involvement and success of girls in STEM subjects at school lead to S&E careers for more women?
- What hurdles do women face throughout their scientific education at secondary and higher education levels and in S&E careers that prevent them from reaching senior positions?
- If women face a glass ceiling and a sticky floor, what can be done to eliminate these barriers?
- How can faculty positions (i.e. tenure track) take into consideration work-life balance?
- How can gender bias in the review processes for assigning new research grants, filling posts, or designing new research policies, be tackled?
- Which currently existing STI policies are biased for or against women in STEM?
- Which STI policy instruments are adequate to promote gender equality in all career stages?
- How can the gender dimension be promoted in research agendas and content?

Designing public policies to promote gender equality, based on evidence and good practices, is becoming a priority in regions across the world to ensure women's full participation in the S&E workforce. As part of this SAGA Toolkit, methodologies are presented to support policy-makers worldwide in setting up, implementing, monitoring and evaluating gender equality policies in STI. These methodologies enable the categorization of policies and policy instruments, assist in identifying gaps in existing STI policies and analyses for the production of regional or country profiles. The approach of evaluating the gender component in STI policies and policy instruments, developed using the conceptual framework of UNESCO Global Observatory of STI Policy Instruments (GO-SPIN), has been integrated in this Toolkit. More information on GO-SPIN can be found in Box 3.

1.4 Indicators on gender equality in STEM

Access to STEM statistics disaggregated by sex is essential to monitor the progress in reaching gender equality in STEM and to evaluate the outcomes of STI policies. However, there are very few statistics on STEM and those available are generally not sufficient to provide insights on the full scope of the gender equality situation. In addition, the absence of a standard definition of what precisely comprises STEM complicates comparisons across the world. Thus, the assessment of the gender gap in STEM at the educational level, in the S&E workforce and on the drivers and barriers to career progression is restricted, thus limiting the monitoring and the evaluation of STI policies and programmes aimed at reducing the gender gap in STEM.

Globally, indicators on the distribution of men and women enrolled in higher education programmes only offer a very general overview of their participation. A breakdown of statistics by broad fields of study shows the differences in men and women's enrolment, and thus enables evaluation of the gaps in specific fields. However, the level of precision at which the fields of study are usually reported is not sufficient to show variations at a finer level and, as a result, differences in gender distribution in subfields of study, such as in chemistry within sciences, will not be explicitly visible.

Box 3: UNESCO Global Observatory of STI Policy Instruments

UNESCO's Global Observatory of Science, Technology and Innovation Policy Instruments, known as GO-SPIN, is a methodological tool to map national STI landscapes and analyse STI policies and their implementation.

The UNESCO GO-SPIN programme was launched in 2012 to strengthen the understanding of STI policies and to help countries to reform and upgrade their national STI systems. The programme promotes evidence-based policy-making and policy learning among countries by enabling the benchmarking of policy instrument performance among countries utilizing the GO-SPIN's analytical framework and open access data platform. The aim of GO-SPIN is to generate reliable and relevant information on the different landscapes of STI policies around the world. The publicly available information comes from national GO-SPIN surveys, combined with government reports and statistical data from UIS and other international sources (UNESCO, 2011).

The programme builds capacities around concepts of policy instruments and delivers training to national officials on the use of the standard practice for data collection and analysis, the GO-SPIN survey. The information gathered in the surveys serves to feed the GO-SPIN multilingual platform, which provides key information and indicators on STI policies, legal frameworks and operation policy instruments. Other important outputs of the programme are the GO-SPIN country profiles published in the UNESCO's online series *Mapping of research and Innovation* and the production of foresight studies in fields such as STI priority setting. These reports include:

a. A long-term description of the political, economic, social, cultural and educational contextual factors;
b. A standard content analysis of the explicit STI policies, including research and innovation policies implemented in other sectors, such as agriculture, energy, health, industry and mining;
c. A study of the national landscape on women in S&E (linked to SAGA);
d. A study of R&D and innovation indicators;
e. A long-term scientometric analysis of scientific publications, patents, trademarks and utility models;
f. A description of the STI policy cycle;
g. A complete analysis of the STI organizational chart at five different levels (policy-making, promotion, research and innovation execution, scientific and technological services, and evaluation);
h. An inventory of all the STI government bodies and organizations related to research and innovation, and to science and technology services;
i. An inventory of the STI legal framework, including acts, bills, regulations and international agreements on STI issues;
j. A standard inventory with 20 different analytic dimensions for all the STI operational policy instruments in place;
k. The analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) of the country's research and innovation landscape.

The GO-SPIN's methodological approach assumes that evidence-based STI policies can be mapped through the study of formal public policies and their different types of policy instruments, as well as the influence of contextual factors.

The strategy of the GO-SPIN programme comprises four dimensions:

i. Capacity building: training high-ranking national officials in the design, implementation and evaluation of a variety of STI policy instruments at national and regional levels.
ii. Standard-setter: providing a standard practice for surveys on STI policies and operational policy instruments.
iii. Data collection: worldwide distribution of the GO-SPIN surveys, prioritizing Africa, Arab States, Asia-Pacific, and Latin American and the Caribbean.
iv. GO-SPIN platform: creation of an online, open access platform for decision-makers, knowledge-brokers, specialists and the general public with a complete set of information on STI policies.

For further information on GO-SPIN, see http://en.unesco.org/go-spin

From the workforce perspective, the unavailability or scarcity of information on men and women engaged in S&E occupations limits the assessment of the gender gaps. Global R&D statistics, reported by the UIS, give information only on a subset of the S&E workforce, namely on researchers. According to recent statistics, women represent nearly 30% of all researchers globally, with regional differences visible across the world. While researchers represent a subset of the S&E workforce, it is foreseeable that the gender gap between women and men also will demonstrate that women are a minority in overall S&E occupations.

This Toolkit aims to address the gender gap in statistics on STEM by establishing standard definitions and classifications for the measurement and reporting of STEM-related data. It also proposes key indicators to inform and support policies in STI by highlighting various data sources and recommending methodologies to increase the informative potential of these sources.

1.5 About the SAGA Toolkit

The SAGA Toolkit is multipurpose and sets out a conceptual and methodological framework to provide a series of tools to integrate, monitor and evaluate gender equality in STEM, and to assist in the design of gender-sensitive and evidence-based policies to strengthen the gender policy agenda. It links together all of the SAGA designed instruments and methodologies to assist in the evaluation of gender-related STI policies coverage, accessing and assessing statistical evidence to support national STI policies on gender equality in STEM.

This Toolkit can be used or adapted by a large range of users, including:

a) **National governments** The Toolkit may assist national governments that would like to improve the design and the implementation of their policies and instruments to make them more effective. The information produced by the implementation of the tools will allow policy-makers, policy analysts and researchers to cluster policies, detect flaws in the policy mix, and establish an agenda for filling the gaps. It is designed to help fill a significant information gap in the policy-making process.

b) **Education and research institutions, national science foundations, development agencies, among other institutions** The Toolkit contains specific tools that can be implemented at an institutional level to map initiatives and measures and to assist in the collection of information on drivers and barriers to careers in S&E. These institutions could also use sex-disaggregated data for reviewing country profiles related to the topic, identify gaps in information, and use the data and information for advocacy.

c) **Evaluators** The Toolkit may be useful for gender audits in order to monitor policy and programme performance and ensure that specific gender equality targets are met.

d) **International institutions, including UN agencies** The Toolkit can be used to conduct assessments, monitor country performance, and to identify questions that need international attention. Sex-disaggregated data could provide standards to target funding and investments properly.

The Toolkit may be used at any stages of the policy cycle, such as agenda setting, policy formulation, implementation, monitoring and evaluation. As a result of this versatility, it is possible that not all tools introduced in this document will be relevant to all users. In fact, the various instruments can be applied together or individually. Taking into account that different countries and agencies have different approaches and structures, the selection of data sources and related indicators will be determined by the type and the scale of the intervention, and thus, may require some adjustment to the national or institutional context.

In order to keep this Toolkit succinct, two complementing tools have been published as separate working papers: the SAGA Survey of Gender Equality in STI Policies and Instruments (Working Paper 3, hereafter referred to as the STI Policy Survey), and the Survey of Drivers and Barriers to Career in Science and Engineering (Working Paper 4, hereafter referred to as the D&B Survey).

The outcomes of the implementation of the SAGA tools and methodologies presented in this Toolkit will be the basis for the elaboration of national reports. These will consist of an overview of the situation of girls and women in STEM, STI policies and instruments focused on gender equality, and of the results of the implementation of the selected SAGA tools. The preparation of reports should be guided by the STI GOL so that all gender objectives are covered. Lastly, these reports will also highlight instances where the collection of data for new indicators was needed to assess the STI gender objectives adequately.

1.6 Structure and contents of the Toolkit

The structure of the Toolkit reflects the approach of the SAGA project, by which STI policies and instruments are linked to indicators related to gender in STEM. For each of the two aspects, policies and statistical evidence, tools have been designed to facilitate the review and analysis of the policy mix and available statistics. Methodological guidelines, which include definitions and classifications for key concepts related to gender, STI and STEM, are provided as standards and are recommended for international comparison purposes.

The conceptual backbone of the project is the SAGA STI GOL (UNESCO, 2016), Working Paper 1, a framework on which all the SAGA tools are predicated. The STI GOL aims at encompassing all aspects of gender equality in STI policy-making. Each of the seven main gender objectives constituting the STI GOL are broken down into sub-objectives for more meaningful and in-depth coverage of policies, as shown in Section 3.4. Achieving each objective involves measuring its status in each particular context, whether at the national, regional or institutional level. Thus, it is necessary to define indicators which, in turn, can facilitate the definition of needs and of success of a policy oriented towards achieving each objective.

Box 4: SAGA STI Gender Objectives List

The STI GOL was developed in an attempt to cover all the aspects of gender equality in S&E careers to identify gaps in the STI policy mix, thereby supporting policy-makers worldwide in setting up, implementing, monitoring and evaluating gender equality in STI policies (UNESCO, 2016). The STI GOL is based on seven areas of objectives or policy impacts:

1. Social norms and stereotypes;
2. Primary and secondary education;
3. Higher education;
4. Career progression;
5. Research content, practice and agendas;
6. Policy-making processes; and
7. Entrepreneurship and innovation.

These seven areas configure the first level of STI gender objectives. A second level provides breakdowns that allow for more meaningful and in-depth analysis:

1. Change perceptions, attitudes, behaviours, **social norms and stereotypes** towards women in STEM in society
   - 1.1. Promote awareness of and overcome non conscious and cultural gender biases widely expressed as gender stereotypes, among scientists, educators, policy-makers, research organizations, the media, and the public at large.
   - 1.2. Promote visibility of women with STEM qualifications, and in STEM careers, especially in leadership positions in governments, business enterprises, universities, and research organizations.
   - 1.3. Mainstream gender perspectives in science communication and informal and non-formal STEM education activities, including in science centres and museums.

Box 4: SAGA STI Gender Objectives List

2. Engage girls and young women in STEM **primary and secondary education**, as well as in technical and vocational education and training

2.1. Promote S&E vocations to girls and young women, including by stimulating interest, fostering in-depth knowledge about S&E career issues, and presenting role models.

2.2. Mainstream the gender perspective in educational content (teacher training, curricula, pedagogical methods, and teaching material).

2.3. Promote gender-sensitive pedagogical approaches to STEM teaching, including encouraging hands-on training and experiments.

2.4. Promote gender balance among STEM teachers.

2.5. Promote gender equality in STEM school-to-work transitions.

3. Attraction, access to and retention of women in STEM **higher education** at all levels

3.1. Promote access of and attract women to STEM higher education (including Masters and Ph.D.), including through specific scholarships and awards.

3.2. Prevent gender bias in the student admission and financial aid process.

3.3. Promote retention of women in STEM higher education at all levels, including through gender-sensitive mentoring, workshops and networks.

3.4. Prevent gender-based discrimination and sexual harassment at all levels, including Masters and Ph.D.

3.5. Promote gender equality in international mobility of students.

3.6. Promote day care/child care facilities for students, particularly at STEM higher education institutions.

4. Gender equality in **career progression** for scientists and engineers (S&E)

4.1. Ensure gender equality in access to job opportunities, recruitment criteria and processes.

4.2. Promote equal work conditions through, among others:

- gender equality in remuneration;
- preventing gender bias in performance evaluation criteria (including productivity measurement);
- adequate safety and security of fieldwork;
- sexual harassment prevention policies and procedures.

4.3. Ensure gender equality in access to opportunities in the workplace:

- training and conferences;
- research teams, networks (national and international), expert panels and advisory groups;
- publications and patent applications, including preventing bias in review;
- financial and non-financial incentives;
- recognition, rewards and awards.

4.4. Promote work–life balance through, among others:

- infrastructure for child care
- flexible working hours
- reduction and redistribution of unpaid care and domestic care
- family leave for both parents
- appropriate re-entry mechanisms to the S&E workforce after career break or family leave.

4.5. Promote gender equality in international mobility of post-docs and researchers, and facilitate women's return.

4.6. Promote gender balance in leadership positions in S&E occupations (including decision-making and research).

4.7. Promote transformations of STI institutions and organizations (structure, governance, policies, norms and values) aimed at achieving gender equality.

4.8. Ensure gender equality in S&E professional certifications, in particular in engineering.

Box 4: SAGA STI Gender Objectives List

5. Promote the gender dimension in **research content, practice and agendas**

5.1. Establish specific gender-oriented R&D programmes, including research on gender in STEM and on the gender dimension of the country's research agenda and portfolio.

5.2. Incorporate gender dimensions into the evaluation criteria of R&D projects.

5.3. Promote gender-sensitive analysis in research hypotheses and consideration of sex of research subjects.

5.4. Promote gender responsive and gender-sensitive research dissemination and science communication, including through science centres and museums, science journalism, specific conferences, workshops, and publications.

6. Promote gender equality in STEM-related **policy-making**

6.1. Ensure gender balance in STEM-related policy design (decision-makers, consultative committees, expert groups, etc.):

- Education policy
- Higher education policy
- STI policy
- Economic policy
- Workforce policy
- SDGs / international policies.

6.2. Ensure gender mainstreaming and prioritization of gender equality in STEM related policy design, monitoring and evaluation:

- Education policy
- Higher education policy
- STI policy
- Economic policy
- Workforce policy
- SDGs / international policies.

7. Promote gender equality in science and technology-based **entrepreneurship and innovation** activities

7.1. Promote gender equality in access to seed capital, angel investors, venture capital, and similar start-up financing.

7.2. Ensure equal access to public support for innovation for women-owned firms.

7.3. Ensure visibility of women entrepreneurs as role models.

7.4. Ensure women's access to mentorship and participation in the design and implementation of gender-sensitive training in entrepreneurship, innovation management, and Intellectual Property Rights.

7.5. Promote networks of women entrepreneurs and women's participation in entrepreneurship networks.

7.6. Promote gendered innovation approaches.

7.7. Promote external incentives and recognition for women-led innovation and acceptance of women innovators in society.

7.8. Promote gender equality in the access and use of enabling technology, in particular information and communication technology.

7.9. Promote a gender balanced workforce and equal opportunities in start-up companies.

The Toolkit is structured around the STI GOL and it is composed of the following tools:

- A set of **definitions and classifications for STI, STEM and S&E,** which are to be used to establish international standards;
- The **SAGA Policy Matrix**;
- The **STI Gender Equality Footprints**;
- The **SAGA Indicators Matrix;** and
- **Methodological guidelines for various indicators sources** in the evaluation of gender equality in STEM.

The **SAGA Survey of Drivers and Barriers to Careers in Science and Engineering (D&B Survey)** and the **SAGA Survey of Gender Equality in STI Policy and Instruments (STI Policy Survey)** are instruments developed to complement the tools of this document and are only briefly introduced in this Toolkit.

The **SAGA Policy Matrix** is a tool to categorize and organize information by the STI GOL on all the STI policies and policy instruments collected using the SAGA STI Policy Survey. The use of these two tools permits a complete overview of STI policies, instruments and actions on gender equality and highlights the potential gaps in the policy coverage, which subsequently helps to define and set priorities and areas to improve in the policy mix and reduce the gender gap in STI.

The **STI Gender Equality Footprints** are a tools to illustrate the profile of gender equality in STI in a country or region. Each of the footprints allows for cross-national or temporal comparisons, and facilitates the identification of specific policy areas where gender equality initiatives can be strengthened. Two STI Gender Equality Footprints are proposed in Section 3.3, each with a different aim and list of parameters:

- The STI Gender Equality Policy Footprint; and
- The STI Gender Objectives Footprint.

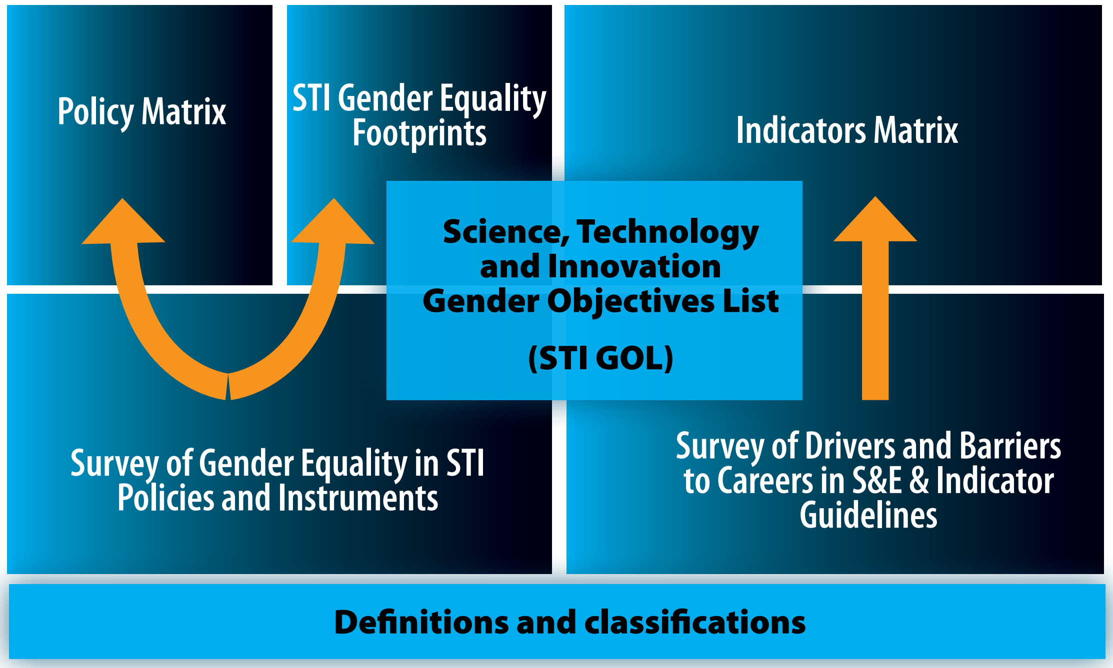
The STI Policy Survey offers a methodology, which complements the GO-SPIN approach (see Box 3), to assess how gender equality is mainstreamed throughout policies and operational instruments currently in place, which provides the main input to develop the SAGA Policy Matrix and the STI Gender Equality Footprints. The STI Policy Survey consists of a set of questions on the gender dimension of policies in STI to inventory and classify the information collected under the STI GOL. The methodological background of the STI Policy Survey is introduced in Section 3, while the complete survey is found in SAGA Survey of Gender Equality in SAGA Working Paper 3.

From the statistical aspect, the **SAGA Indicator Matrix** proposes a list of indicators that are most relevant for the objectives and sub-objectives of the STI GOL and is a guiding tool to review the information available and evaluate gender equality in STEM. This enables the assessment of the effects of policies and instruments in STI for the promotion of gender equality. The Indicator Matrix also suggests sources that may contain useful data. Methodological guidelines and recommendations on how to produce relevant indicators to help optimize the potential from these various data sources on gender equality in STEM are found in Section 5 (**Indicator sources and guidelines**). The selected indicators presented in the Indicator Matrix represent lead indicators and do not represent an extensive list of indicators. Similarly to the exercise recommended for the policy aspect, a review of all the indicators can be carried out in parallel with the STI GOL to assess the availability of statistical evidence to support and evaluate the efficiency of STI policies and instruments in promoting gender equality in STEM.

Some gender objectives relate to contexts and personal experience for which most aggregated sources of data do not inform adequately on factors potentially affecting gender equality. To address this issue, SAGA has developed a tool to evaluate the drivers and barriers faced by the STEM population, the D&B Survey. The methodological background of the survey is introduced in Section 5.1 and the complete methodology and survey are available in SAGA Working Paper 4.

The two matrices, the SAGA Policy Matrix and the SAGA Indicators Matrix, have been developed to enable a linkage between policies and evidence, with the STI GOL as the common element. A review of the two matrices in parallel enables a review of the policy coverage and information available as evidence in the evaluation of gender gaps in STEM. The relation across all the tools and instruments of the Toolkit are structured around the STI GOL, as presented in Figure 4.

Figure 4: Links and interactions between the SAGA tools



Box 5: Piloting the SAGA tools across the world

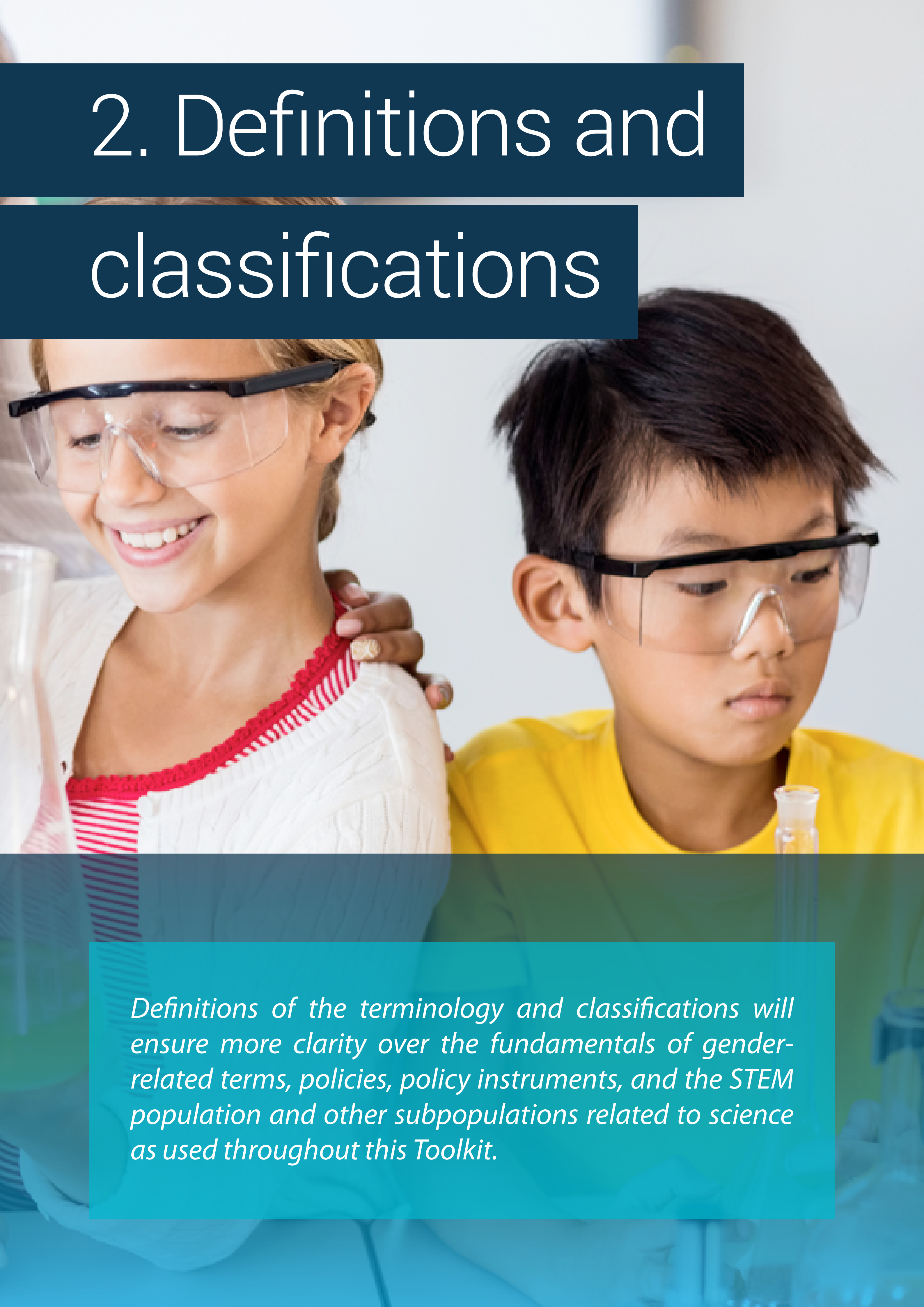
The tools developed in the framework of the SAGA project and found in this Toolkit are currently under implementation and review in countries, regions and institutions across the world, which have volunteered to join the SAGA initiative. The tools under review are selected based on the following objectives:

- Identify main gaps in gender-related STI policies using the STI GOL;
- Assess the coverage of national STI gender-related policies;
- Collect information on drivers and barriers to careers in S&E;
- Draw information from various sources of data to gain a better understanding of the STEM population and to use as evidence for STI policies.

SAGA's capacity-building activities, organized as workshops, mark the official launch of the project in host countries, regions, and institutions and formally introduce national teams and key stakeholders to the SAGA instruments. During these events, support is provided for the implementation of all the tools included in this Toolkit.

Capacity-building activities represent an important contribution both for pilots and the SAGA project through the evaluation of the coverage of STI policies and statistics to address gender gaps in STEM and to improve the instruments and guidelines to help address gaps and ensure a better coverage.

In the final phase of the project and as a result of capacity-building activities, all SAGA pilot countries, regions or institutions will produce a report on the implementation of the SAGA tools. All policies and indicators presented in these reports will be reviewed and incorporated into the UIS STI Statistics Database and the UNESCO GO-SPIN database (which will be launched in the 2018). Lastly, the final version of the Toolkit will contain all the tested methodological proposals, lessons learned and best practices, will be published as a reference guide for the promotion of gender equality in STEM.



2. Definitions and classifications

Definitions of the terminology and classifications will ensure more clarity over the fundamentals of gender-related terms, policies, policy instruments, and the STEM population and other subpopulations related to science as used throughout this Toolkit.

In this section, key terms related to gender, and technical definitions and classifications for uses of STEM in education and the workforce are provided to ensure a common understanding of terms and concepts used throughout the Toolkit.

As mentioned in the previous section, the Toolkit's purpose is to provide all users with a set of tools to evaluate and monitor the coverage of STI policies in order to improve gender equality in STEM. Therefore, a set of key gender-related terms is first defined to ensure a consensus. Main concepts and classifications are also explained in detail prior to the presentation of the different methodologies and tools. The explanations of terminology will ensure more clarity over the fundamentals of policies, policy instruments, and the STEM population and other subpopulations related to science as used throughout this Toolkit.

2.1 Gender-related terms

Sex describes the biological differences between men and women.

Gender refers to the roles and responsibilities that are created in families, societies and cultures, which thus are considered appropriate for women and men in a given society at a given time. It includes expectations about characteristics, attitudes and behaviours. Gender roles and expectations are learned. They can change over time and vary between different societies, cultures and groups. Gender roles can be modified by political status, class, ethnicity, disability, age or other factors. Since gender is a social construct, it can be modified and policies can have an effect to overcome what might be considered inherent power roles (UNESCO, 2014).

Sex-disaggregated data is data that is collected and presented separately for men and women.

Gender parity is a numerical concept for same proportions in representation and participation. Gender (or sex) parity does not necessarily imply gender equality. It is a necessary but not sufficient step on the road to gender equality (UNESCO, 2014, p. 60). It does not address the quality, only the quantity of men and women in a given organisational unit, so it is not an automatic solution to inequalities that may exist (UN, 2017).

Example: The UN Gender Strategy Report states: 'While the goal is 50/50 parity, it is recognized that sustainability at that number is unlikely and for the purposes of this strategy parity is considered to be within the 47%-53% margin' (UN, 2017, p. 7). SAGA considers it is acceptable to vary from 45%-55%.

Gender equity is the process of being fair to men and women. Targeted measures must often be put in place 'to compensate for the historical and social disadvantages that prevent women and men from operating as equals' (UNESCO, 2014, p. 60). Gender equity can be considered as a step towards gender equality that recognizes the socioeconomic, cultural, physical psychological, and other factors that make each person different (UNESCO, 2013).

Example (see also Figure 5): Imagine that several people of different heights are trying to see out of a window. Because each is of different height, only the tallest person is able to see out of the window, and the others cannot because they are too short. If all the people standing are provided with a stool of the same height, the majority will likely not be able to see out of the window because they will be too tall or too short. However, equity takes into consideration people's differences. Therefore, equity would be to provide each person with a stool adjusted to their height so that each could see equally well out of the window.

Figure 5: Illustration of equity

An image from the film *The Good Governance Recipe*, The Water Rooms project, UNESCO World Water Assessment Programme, (UNESCO, 2015b).

Gender equality exists when women and men enjoy the same status and have equal conditions, treatment, and opportunities for realizing their full potential, human rights and for contributing to and benefitting from economic, social, cultural and political development. Equality does not mean that women and men will become the same but that women's and men's rights, responsibilities and opportunities will not depend on their sex or gender. Gender equality is therefore the equal valuing by society of the similarities and differences between women and men and the different roles that they play. It is not about sameness (UNESCO, 2014).

Gender mainstreaming Mainstreaming a gender perspective is the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes in all areas and at all levels. It is a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres, so that women and men benefit equally, and that inequality is not perpetuated. The ultimate goal is to achieve gender equality (ECOSOC, 1997).

Gender analysis is the collection and analysis of gender-disaggregated information. Women and men may have different experiences, knowledge, talents and needs. Gender analysis explores these differences so that policies and programmes can identify and meet the different needs of men and women. It also facilitates the strategic use of any distinct knowledge and skills held by women and men. It is a crucial first step towards gender-responsive planning (UNESCO, 2014).

2.2 STEM, STI and S&E

The acronym 'STEM' is widely used when referring to the fields of science, technology, engineering and mathematics. However, the situations where it is useful can vary widely based on the context in which it is referenced. To avoid any confusion, this section clearly defines main concepts related to STEM from terms used in specific contexts to technical definitions and classifications for uses of STEM in education and the workforce. The establishment of a clear definition and classification sets the conceptual framework for measuring STEM education and the S&E labour force as international standards.

The concept of STEM can be defined in numerous ways, depending on the perspective chosen and data used to account for it statistically. Nowadays, not only do we have numerous definitions of STEM, but we also have branded numerous entities to be STEM councils, STEM networks and STEM schools. There is also a movement advocating for the inclusion of the arts to STEAM (see Box 6 for further details on this term). At the moment, no internationally recognized definition of STEM in terms of concept and classification has been adopted, which prolongs the ambiguity of what is STEM, especially from the statistical point of view.

For the purpose of this Toolkit, three STEM-related terms have been chosen when referring to specific aspects. These are:

- **Science, technology, engineering and mathematics – STEM** – is used to characterize the corresponding fields of knowledge and study. It refers to the formal education and qualifications individuals acquire throughout their training in the fields of science, in technology, engineering and mathematics;
- **Science, technology and innovation – STI** – is used when referring to policies. It refers to measures, decisions, interventions or activities that have an impact on STEM fields; and
- **Scientists and engineers – S&E** – is used when dealing with professions in the fields of science and engineering, most frequently carried out by graduates of STEM higher education careers, but not necessarily.
    - Additionally, the acronym S&E is also used in reference to 'science and engineering' fields. It is thus advised to adopt the meaning of the acronym which best suits the context in which it is used.

Box 6: STEM vs. STEAM

In recent years, there has been considerable discussion over the inclusion of the arts to the STEM acronym, resulting in 'STEAM' – science, technology, engineering, arts (and design) and mathematics. While there is little disagreement over the interaction between the arts and science, there is no universal conclusion over the inclusion of arts into STEM (Xanthoudaki, 2017). The use of STEM in this Toolkit, rather than STEAM, is motivated by a focus on natural sciences and engineering and practical aspects of data collection and analysis, which challenges the inclusion of arts and design into the technical definition of STEM.

In defining STEM from the educational and the occupational point of view, international classifications are used to measure the broad concept of STEM concretely. The challenge in the inclusion of arts and design to the definition of STEM arises from the field of study categories (and subcategories) of these classifications.

From the educational perspective, fields of study used to define programmes of higher education are generally broadly reported at the global level using the ISCED. It should, however, be included at the national level. Practically, this implies that an important subset of arts and humanities would need to be included in the existing STEM categories. This subset of fields of study is usually not available at the international level and would result the inclusion of non-STEM population. It is important to note that the most important sector of design for innovation, industrial design, is not part of arts and humanities, but it is rather part of engineering and engineering trades, and as such is already included in STEM.

From the occupational perspective, specifically from the fields of R&D, arts falls under the broad category of Humanities and the arts, which, if using STEAM, poses the problem of including humanities in STEM. So, for R&D statistics to evaluate and monitor gender equality in STEM, adding arts in the definition of STEM is not feasible since general access to statistics, specifically for a narrow field such as arts, is difficult.

For these reasons, SAGA is committed to the use of STEM rather than STEAM to measure and evaluate gender equality in STEM purely from the natural sciences and engineering fields. The role of the arts in communicating science and engaging learners in science education is beyond the scope of SAGA's objectives.

2.3 Science, technology and innovation policy and operational instruments

A gender perspective in policies is important because all policies impact men's and women's lives in one way or the other as 'economic and social differences between men and women, policy consequences, intended and unintended, often vary along gender lines. It is only through a gender analysis of policy that these differences become apparent, and solutions devised' (Chappell, et al., 2012, p. 228). Policies have the capacity to perpetuate or address discrimination and gender inequality. There is a general failure to recognize that gender is an essential determinant of social outcomes with an impact on policies and instruments. A gender-blind approach assumes gender is not an influencing factor in projects, on programmes or policies.

A **public policy** is a formal decision, a plan, a collection of laws, directives, regulatory measures or laws with funding priorities and regulations established through a political process, concerning a given topic promulgated by a governmental entity (local, national or supra-national) or its representatives (Richards & Smith, 2002). A public policy can also be defined as 'a series of decisions or actions, intentionally coherent, taken by different actors, public and sometimes not public - whose resources, institutional links and interests vary - in order to resolve promptly problem politically defined as collective', with an objective of public interest (Humet, et al., 2008). Any policy needs to be implemented by a set of policy instruments to foster the desired outcome.

STI policies are statements on STI made by high-level government officials or representatives of the private sector, generally associated with top-level government bodies. They include sets of measures, decisions and interventions, and executive arrangements to effectively implement national and subnational STI policies plans (national development plan or strategy), legislation, and decisions regarding the allocation of resources (Sagasti, 2011).

STI operational instruments, as intended in this Toolkit, are specific ways and means used to implement STI policies. They respond to the question of how a specific policy is put into practice. They are the levers, or actual means, by which the organizational structure ultimately implements decisions on a day-to-day basis and attempts to produce the desired effect on the variables the policy has set out to influence. Throughout the analysis of an instrument it is important to keep in mind the actors or key decision-makers who are directly involved in its design and use. Policy instruments may come, for example, as programmes for technical assistance, scholarships or fellowships, training, awards and competitions, creation and aid for technology hubs and centres of excellence, donations (from individuals or companies), science fairs, or tax credits (see Box 7).

Example: Scholarship extension during parental leave (including maternity, paternal and adoption leave) or activities to raise awareness of the need to enable women to hold leading positions at research organizations.

Box 7: Types of STI policy operational instruments

STI policy operational instruments are specific means used to implement policies. They respond to the question 'how' a particular policy is made effective to understand the means by which it is put into practice.

There are many different types of policy instruments. The GO-SPIN classification is used in the Policy Matrix. It includes:

A. Technical assistance
B. Scholarships or fellowships
C. Training
D. Awards and competitions
E. Creation and aid of technological poles and excellency centres
F. Donations (individuals or companies)
G. Fairs
H. Trust funds
I. Financial guaranty
J. Credit incentives and venture capital
K. Fiscal incentives
L. Loans
M. Information services
N. Subsidy (non-reimbursable contributions).

Nature of the gender impact. It is possible that not all instruments are directly aimed at achieving gender equality. They may have a **direct impact** or a **differential gender impact**.

- **Direct impact** is used for instruments aimed at achieving gender equality in STI. These instruments, regulations, policies and programmes are set in place with the purpose of having a direct gender impact affecting the living conditions and access to resources for women and men.
- **Differential gender impact** is used when instruments are aimed at an objective other than gender but do have an indirect impact on gender equality.

Explicit policy is a statement referring directly to the objectives and decisions that policy-makers want to influence (Sagasti, 1976).

Implicit policy is a statement referring to other objectives and decisions, different from those that policy-makers want to influence, but that have an indirect effect in shaping the behaviour of agents targeted by the explicit policy (Sagasti, 1976).

2.4 Other useful definitions

Other terms may be relevant to users for the use of the SAGA tools. These are defined in this section to provide clarity and assistance.

Researcher 'Researchers are professionals engaged in the conception or creation of new knowledge. They conduct research and improve or develop concepts, theories, models, techniques instrumentation, software or operational methods' (OECD, 2015a, p. 162).

Scientists and engineers (S&E) 'refer to persons who, working in those capacities, use or create scientific knowledge and engineering and technological principles, i.e. persons with scientific or technological training who are engaged in professional work on science and technology (S&T) activities, high-level administrators and personnel who direct the execution of S&T activities' (OECD & Eurostat, 1995, p. 69).

Student Individual who is enrolled in an education programme for the purpose of learning. The term pupil may be used for students under the age of 18-20 years who attend school (UNESCO-UIS, 2016).

- **New entrants** are students who, during the course of the reference school or academic year, enter a programme at a given level of education for the first time, irrespective of whether the students enter the programme at the beginning or at an advances stage of the programme (UNESCO-UIS, 2016, p. 19).
- **First-time new entrants to tertiary education** are students who have not previously been enrolled in any other programme at the tertiary level (UNESCO-UIS, 2016, p. 20).
- A **graduate** is a person who, during the reference school or academic year, has successfully completed an education programme (UNESCO-UIS, 2016, p. 20).

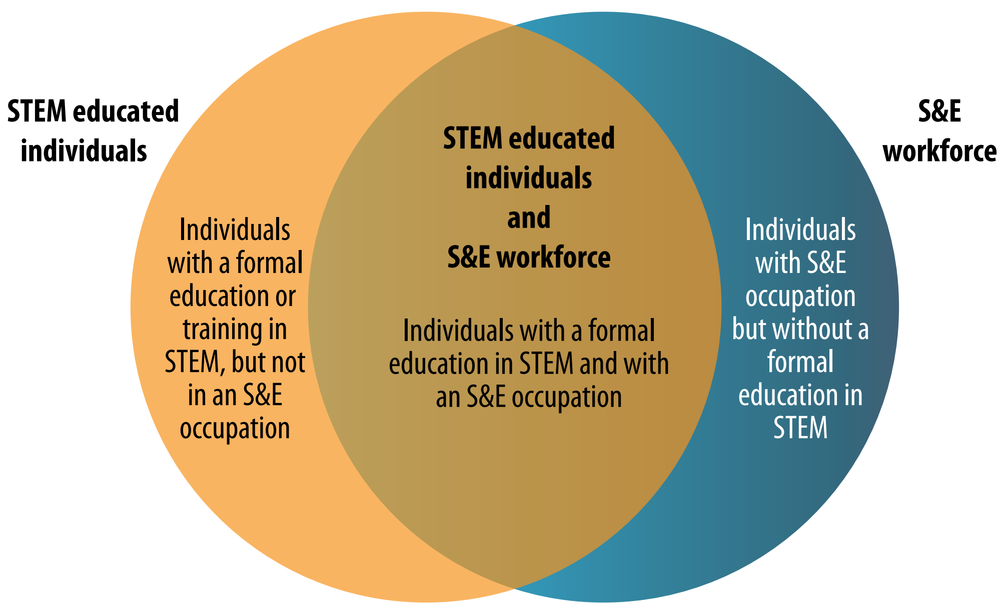
2.5 STEM population

Despite the fact that references to the 'STEM population' are common, the actual definition of who is included in this population remains vague and can vary considerably across sources. To this day, no standard definition has been adopted internationally, thereby failing to establish a common understanding of who is part of the STEM population. This limits evaluation and comparison across the world.

The STEM population is commonly understood as consisting of all people having knowledge and skills in STEM generally acquired through formal education, and which enables them to engage in careers in S&E. While most of them hold a higher education qualification in a STEM field, not all individuals necessarily do. Some individuals may not have a formal education in STEM at a higher level but, through work experience, will have acquired the skills required for an S&E career. Similarly, those who have received a postsecondary education in STEM may not have an occupation as S&E for a number of reasons. The SAGA project's conceptual approach and definition of the STEM population is comprehensive of all individuals related to STEM, no matter the nature of their link to STEM.

As illustrated in Figure 6, the STEM population is composed of individuals who can be classified based on two main attributes: STEM educated individuals (left side) or individuals in the S&E workforce (right side). The intersecting area includes all of those who are STEM educated and who are part of the S&E workforce (centre). The definitions and classifications for the STEM population from the educational and workforce points of views are set in place to assist in the creation of indicators to monitor and evaluate the STI policies and operational instruments in place.

Figure 6: STEM population: conceptual approach



The STEM population illustrated in Figure 6 also sets the population of reference in the remainder of the SAGA Toolkit and in other working papers of the SAGA series, such as the general target population referred to in SAGA D&B Survey (Working Paper 4). Users of the tools can select a specific segment of the STEM population based on their needs or constraints.

2.5.1 STEM education

Receiving a higher education in STEM prepares individuals for careers in S&E. However, there is no official agreement on the specific fields of STEM education. In the framework of the SAGA project, an international standard definition for STEM education has been developed following the *International Standard Classification of Education (ISCED)* (UNESCO-UIS, 2012). ISCED is used as the reference guide for categorizing education programmes by education levels and fields of study. It is intended to be internationally comprehensive of the range of education systems.

The UIS is responsible for ISCED and works closely with the Organisation for Economic Co-operation and Development (OECD) and Statistical Office of the European Commission (the Eurostat) to ensure their mappings are in agreement with the ISCED classification (OECD, 2015a). Levels of schooling and educational programmes in which STEM skills are acquired must be clearly defined to identify individuals who have received a formal education in STEM. A formal education in STEM as defined by SAGA has two conditions, which are both necessary for individuals to qualify as having an education in STEM. First, they must be enrolled or have completed an education at the postsecondary tertiary level or higher. Second, this education be in one of the STEM fields as defined in this section. These two conditions, which are essential in defining STEM education, are explained in greater detail in the next section.

Levels of education

The ISCED levels of education represent the 'degree of complexity and specialisation of the content of an education programme, from foundational to complex' (OECD, 2015a, p. 10). The more advanced the programme, the higher the level of education. All levels are presented in Table 1.

The most recent coding of educational levels, ISCED 2011 (UNESCO-UIS, 2012), is used to define one of the conditions defining STEM education. STEM educated men and women are considered those with a level of education from Short-cycle tertiary education (ISCED 5) to Doctoral or equivalent level (ISCED 8) in a STEM field, which are defined in the next section. In general, Master's and Doctoral students will have completed an education at ISCED 6 level (Bachelor's) and, if enrolled, will be studying at ISCED 7 (Master's level or equivalent) or at ISCED 8 (Doctoral level or equivalent). Doctoral students usually attend a programme leading to the attainment of an advanced research qualification, if they are engaged in research.

Table 1. ISCED 2011 Coding of levels of education

Level	Title of level
Level 0	Early childhood education
Level 1	Primary education
Level 2	Lower secondary education
Level 3	Upper secondary education
Level 4	Postsecondary non-tertiary education
Level 5	Short-cycle tertiary education
Level 6	Bachelor's or equivalent level
Level 7	Master's or equivalent level
Level 8	Doctoral or equivalent level

Fields of education and training

The revision of the ISCED fields of education and training (ISCED-F 2013) was conducted in a separate process from the ISCED 2011 revision to set in place an independent, yet related, classification, which can be updated independently (UNESC O-UIS, 2014b). The reviewed list of fields consists of 11 broad fields of study (first level), subdivided into 29narrows fields (second level) and further separated into approximately 80 detailed fields (third level).[5]

The fields of study which refer to disciplines of formal STEM education, the second criterion for STEM education, are grouped under three of the

5. A complete list of the fields of education from ISCED-F 2013 can be found at http://www.uis.unesco.org/Education/Documents/isced-fields-of-education-training-2013.pdf.

11 broad groups of ISCED-F 2013, namely:

- 05 Natural sciences and mathematics;
- 06 Information and communication technology; and
- 07 Engineering, manufacturing and construction.

These three broad categories are divided in subcategories (narrow and detailed fields), all of which are implicitly included in the broad categories for each of the disciplines defining STEM education (see Table 2). Data collected and reported on the fields of study should be presented as detailed as possible to minimize the effects of variations across subdisciplines. In some instances, sample sizes may be too small for reporting, in which case it should be reported at the most detailed level possible.

Table 2. STEM-variant of ISCED-F 2013

Broad and narrow fields	Detailed fields
05 Natural sciences, mathematics and statistics	
051 Biological and related sciences	0511 Biology
	0512 Biochemistry
052 Environment	0521 Environment sciences
	0522 Natural environments and wildlife
053 Physical sciences	0531 Chemistry
	0532 Earth sciences
	0533 Physics
054 Mathematics and statistics	0541 Mathematics
	0542 Statistics
06 Information and communication technologies	
061 Information and communication technologies	0611 Computer use
	0612 Database and network design and administration
	0613 Software and applications development and analysis
07 Engineering, manufacturing and construction	
071 Engineering and engineering trades	0711 Chemical engineering and processes
	0712 Environmental protection technology
	0713 Electricity and energy
	0714 Electronics and automation
	0715 Mechanics and metal trades
	0716 Motor vehicles, ships and aircraft
072 Manufacturing and processing	0721 Food processing
	0722 Materials (glass, paper, plastic and wood)
	0723 Textiles (clothes, footwear and leather)
	0724 Mining and extraction
073 Architecture and construction	0731 Architecture and town planning
	0732 Building and civil engineering

In conclusion, to be part of the STEM educated population, individuals must have an academic qualification at ISCED level of education between level 5 and level 8 and it must be in one of the three broad STEM fields: natural sciences, mathematics and statistics; information and communication technologies; or engineering, manufacturing and construction. Anyone who has both of these requirements qualifies as being in the STEM educated population, regardless of their employment field or status as it is defined in the following section.

2.5.2 S&E workforce

As demonstrated in Figure 6, the STEM population as defined in the SAGA Toolkit can be looked at from the formal education or occupational aspect. In this respect, the S&E workforce only refers to individuals with an occupation in S&E, independently of the level of education and field of study attained.

The S&E workforce consists of individuals who have occupations for which STEM skills are used to solve problems in an innovative approach. These skills can be acquired formally, through a formal STEM education as presented in the previous section, or informally, through post-hiring training or professional experience acquired over time and applied in a day-to-day occupation. As a result, the S&E workforce is used to refer to all individuals with an occupation in S&E, regardless of their formal level of education or field of study.

The occupations defined as S&E professions are categorized using the International Labour Organization (ILO) *International Standard Classification of Occupation* (ISCO), thereby establishing an international baseline for the S&E workforce (ILO, 2012). The use of the ISCO classification will facilitate consistent data collection and comparison for national and international purposes. The ILO's ISCO 2008 (ISCO-08), the latest ISCO revision, is a structured organization of occupational information. ISCO-08 is a four-level hierarchical classification and has ten major occupational groups, presented in Table 3, which enables the categorization of all occupations around the world. The general classification of S&E occupations falls mainly under two of the major ISCO-08 groups: group 2 Professionals and group 3 Technicians and associate professionals.

A variant to isolate S&E occupations has been developed to accommodate users' access to the information on occupations with the SAGA tools. Considering that the data may not always be available or accessible at a detailed level, which enables an evaluation of gender distribution by specific S&E occupations, two subvariants of S&E occupations are made available: a basic coverage (including only two of the main occupational subgroups) and a complete coverage (including occupation groups from all levels of hierarchy) to assist during technical data analyses and evaluations – see Table 4). The difference between the two types of coverage are predominantly in the inclusion of subgroups (at 3-digit or 4-digit level). All efforts towards the collection of employment data with the highest precision possible is encouraged whenever possible. For a visual illustration of these groups, see Table 4.

Table 3. ISCO-08 Major groups of occupations

Major groups	
1	Managers
2	Professionals
3	Technicians and associate professionals
4	Clerical support workers
5	Services and sales workers
6	Skilled agricultural, forestry and fishery workers
7	Craft and related trades workers
8	Plant and machine operators, and assemblers
9	Elementary occupations
0	Armed forces occupations[1]

1. This groups includes some individuals who quality as the S&E workforce. However, it would be very difficult to distinguish the S&E occupations from others within this group. As a result, this group is excluded from the SAGA defined S&E workforce.

More technically, the **basic coverage** assumes access to the classification at 2-digit level and thus, includes:

- group 21 Science and engineering professionals; and
- group 31 Technicians and associate professionals.
    - If it is at all possible, the 3-digit group 231 University and higher education teachers should also be included in this coverage.

In the complete coverage for S&E occupations, subgroups of three of the ten majors groups are included. More specifically:

- From group 1 Managers
    - group 12 Administrative and commercial managers in:
        - group 1223 Research and development managers, also known as managers and administrators of scientific and technical aspects of research. Individuals in this category are usually employed at the same or higher level as researchers and may also conduct research on a part-time basis.
- From group 2 Professionals, the following groups should be included as S&E workforce:
    - group 21 Science and engineering professionals;
    - group 23 Teaching professionals. All subgroups under these 2-digit groups should be included except group 216 Architects, planners, surveyors and designers, which should be excluded whenever possible due to the occupational tasks of this group which do not correspond to S&E occupations as defined by the SAGA project.
    - group 26 Legal, social and cultural professionals; only the following four 4-digit groups should be included from group 263 Social and religious professionals:
        - 2631 Economists;
        - 2632 Sociologists, anthropologists and related professionals;
        - 2633 Philosophers, historians and political scientists, and
        - 2634 Psychologists.

          Note: The inclusion of these four subgroups is relatively rarely reported. Thus, when data for group 263 Social and religious professionals is only available at the 3-digit level, it should be excluded from the complete coverage.
- From group 3 Technicians and associate professionals, only the 2-digit group 31 Science and engineering associate professionals is included in the complete coverage. This includes all of the five 3-digit subgroups (311, 312, 313, 314, and 315) and their respective 4-digit subgroups.

Table 4. S&E occupations; types of coverage of the S&E population

S&E occupations; types of coverage		
ISCO-08 groups of occupations	Coverage	
	Basic	Complete
1 Managers		
12 Administrative and commercial managers		
122 Sales, marketing and development managers		
1223 Research and development managers		X
2 Professionals		
21 Science and engineering professionals	X	
211 Physical and earth science professionals	X	X
212 Mathematicians, actuaries and statisticians	X	X
213 Life science professionals	X	X
214 Engineering professionals (excluding electrotechnology)	X	X
215 Electrotechnology engineers	X	X
216 Architects, planners, surveyors and designers	X*	
22 Health professionals		
23 Teaching professionals		
231 University and higher education teachers	X**	X
2310 University and higher education teachers	X**	X
24 Business and administration professionals		
25 Information and communications technology professionals		
26 Legal, social and cultural professionals		
261 Legal professionals		
262 Librarians, archivists and curators		
263 Social and religious professionals		
2631 Economists		X
2632 Sociologists, anthropologists and related professionals		X
2633 Philosophers, historians and political scientists		X
2634 Psychologists		X
2635 Social work and counselling professionals		
2636 Religious professionals		
264 Authors, journalists and linguists		
265 Creative and performing artists		
3 Technicians and associate professionals		
31 Science and engineering associate professionals	X	X
311 Physical and engineering science technicians	X	X
312 Mining, manufacturing and construction supervisors	X	X
313 Process control technicians	X	X
314 Life science technicians and related associate professionals	X	X
315 Ship and aircraft controllers and technicians	X	X

* Exclude if possible; ** include if possible.
Note: Only relevant groups are presented in detail in this table.

2.6 STEM subpopulations and classifications

There are subsets of the STEM population which are often studied and which are closely related to the STEM population, especially to the S&E workforce section of the STEM population. In this section, the main variant of the S&E workforce related to the SAGA defined STEM population, and its associated classification, is presented to avoid misunderstanding and clearly highlight the differences across these groups. This variant is the R&D personnel.

2.6.1 R&D personnel

R&D personnel is closely related to the S&E workforce based on the research and technical types of activities this group performs, and therefore, classifies as a subset of the S&E workforce. The *Frascati Manual* (FM) sets guidelines for measuring R&D personnel and expenditures for different sectors of activity (OECD, 2015b) and defines three groups of R&D personnel: researchers, technicians and equivalent staff, and other support staff.

Based on the nature of their tasks (and not on job position), only researchers and technicians and equivalent staff are considered to be a subset of the S&E workforce as defined by SAGA under the STEM population (see Figure 8). Therefore, only these two groups should be included in the statistics from R&D reported in reference to the STEM population (see Section 5.4 more information and recommendations). Box 8 gives more details on R&D personnel as defined in the FM.

Lastly, R&D personnel activities can be classified based on the field(s) in which research is conducted. The recommended fields for collecting and classifying research activities are the Fields of Research and Development (FORD) presented in the next section. The selection of the FORD to include in analyses on R&D personal activities are at the discretion of users of this Toolkit and should be based on their goals and priorities.

Fields of research and development

The OECD FORD classification was elaborated to categorize R&D performing units based on the field of knowledge in which an R&D activity is carried out. Based primarily on a content approach, the FORD classification has a broad (1-digit) and a narrow (2-digit) level, which are based on a large range of subjects in science and technology S&T and knowledge-based activities. The FORD classification is recommended to classify the subject(s) in which researchers and other institution staff conduct their research. It is also recommended to collect data at a level as detailed as possible (at 2-digit level) to gain a better perspective of the distribution and variations across subfields, which could be missed at an aggregated level. In research, the STEM fields are those in natural sciences and engineering. The FORD are found in Table 5.

Seniority grades

A classification for the seniority of academic staff Commission and has been added to the FM 2015 (European Commission, 2013; OECD, 2015b). The FM recommends collecting information by seniority grade at national level using R&D surveys for the higher education and the government sectors. The information on seniority can also be collected in educational institutions for relevant staff and from their respective administrative records system. As levels of seniority and position ranking tend to vary across countries, the European Union seniority grades in the FM 2015 permit comparisons and provide information on researchers. The seniority grades are presented in Table 6.

Seniority grades are useful for the measurement of vertical segregation and career progression for researchers. For example, it facilitates the evaluation of career advancement from graduation to the different career stages of researchers by looking at the distribution of men and women at each grade and by age.

Box 8: OECD *Frascati Manual*: R&D Personnel

As defined in the FM, R&D personnel are classified based on their R&D function and consist of the three following groups: researchers, technicians, and other supporting staff (OECD, 2015b).

Researchers

- 'Researchers are professionals engaged in the conception or creation of new knowledge. They conduct research and improve or develop concepts, theories, models, techniques instrumentation, software or operational methods.' (FM §5.35)
- 'Managers and administrators engaged in the planning and management of the scientific and technical aspects of a researcher's work are also classified as 'researchers'. Their position in the unit is usually equal or superior to that of persons directly employed as researchers; they are sometimes part-time researchers.' (FM §5.38)
- 'For practical reasons, doctoral students engaged in R&D should be counted as 'researchers'. They typically hold basic university degrees (ISCED level 7) and perform research while working towards their doctoral thesis (ISCED level 8). When they cannot be identified separately, they may be included either with technicians or with researchers; however, such practices may cause inconsistencies in the researcher series.' (FM §5.39)
- 'Master's students may in some cases be counted as researchers. This applies, in particular, to students following an ISCED level 7 research master's programmes, i.e. those leading to the award of research qualifications that are designed explicitly to train participants in conducting original research but are below the level of a doctoral degree. However, it is important to include in R&D personnel totals only master's students receiving some form of payment for their R&D activity or for which a significant FTE research component can be reliably identified and separated from the tuition component totals.' (FM §5.30)

Technicians and equivalent staff

- 'Technicians and equivalent staff are persons whose main tasks require knowledge and experience in one or more fields of engineering, the physical and life sciences, or the social sciences, humanities and the arts. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods and the use of research equipment, normally under the supervision of researchers.' (FM §5.40)

Other support staff

- 'Other supporting staff includes skilled and unskilled craftsmen, and administrative, secretarial and clerical staff participating in R&D projects or directly associated with such projects.' (FM §5.43)

Table 5. Fields of research and development

Major fields of science	Broad classification (1-digit)	Second-level classification (2-digit)
Natural Sciences and Engineering	1. Natural sciences	1.1. Mathematics
		1.2. Computer and information sciences
		1.3. Physical sciences
		1.4. Chemical sciences
		1.5. Earth and related environmental sciences
		1.6. Biological sciences
		1.7. Other natural sciences
	2. Engineering and technology	2.1. Civil engineering
		2.2. Electrical engineering, electronic engineering, information engineering
		2.3. Mechanical engineering
		2.4. Chemical engineering
		2.5. Materials engineering
		2.6. Medical engineering
		2.7. Environmental engineering
		2.8. Environmental biotechnology
		2.9. Industrial biotechnology
		2.10. Nano-technology
		2.11. Other engineering and technologies
	3. Medical and health sciences	3.1. Basic medicine
		3.2. Clinical medicine
		3.3. Health sciences
		3.4. Medical biotechnology
		3.5. Other medical science
	4. Agricultural sciences and veterinary sciences	4.1. Agriculture, forestry, and fisheries
		4.2. Animal and dairy science
		4.3. Veterinary science
		4.4. Agricultural biotechnology
		4.5. Other agricultural sciences
Social Sciences and Humanities	5. Social sciences	5.1. Psychology and cognitive sciences
		5.2. Economics and business
		5.3. Education
		5.4. Sociology
		5.5. Law
		5.6. Political science
		5.7. Social and economic geography
		5.8. Media and communications
		5.9. Other social sciences
	6. Humanities and the arts	6.1. History and archaeology
		6.2. Language and literature
		6.3. Philosophy, ethics and religion
		6.4. Arts (arts, history of arts, performing arts, music)
		6.5. Other humanities

Table 6. Seniority grades for researchers in the higher education and government sectors

Seniority grade	Description of grade
Grade A	The single highest grade or post at which research is normally conducted. *Example: Full professor*
Grade B	Researchers working in positions not as senior as top position (A) but more senior than newly qualified doctoral graduates (ISCED 8). *Example: Associate professor or senior researcher*
Grade C	The first grade or post into which a newly qualified doctoral graduate would normally be recruited. *Example: Assistant professor or post-doctoral fellow*
Grade D	Either doctoral students at the ISCED level 8 who are engaged as researchers, or researchers working in posts that do not normally require a doctorate degree. *Example: Ph.D. students or junior researchers (without a Ph.D.)*

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Box 9: Human resources in science and technology

Human resources in science and technology (HRST), which are defined in the *Canberra Manual* (CM) (OECD & Eurostat, 1995), are closely related to the S&E workforce, but cover a broader group of individuals. The CM provides guidelines for measuring the stocks and flows of S&T human resources in the labour force. The basic definition of HRST has some similarities with how the S&E workforce is defined in this Toolkit and uses two conditions, which individuals can fulfil in order to be included in the HRST population. These are the educational qualification and the occupation. While the concept is similar, the classifications for identifying the HRST and the SAGA STEM population are fairly different considering the breadth of occupations.

Of greater interest here is how the S&E workforce is defined in the CM, where S&E are 'persons who, working in those capacities, use or create scientific knowledge and engineering and technological principles, i.e., persons with scientific or technological training who are engaged in professional work on S&T activities, high-level administrators and personnel who direct the execution of S&T activities' (OECD & Eurostat, 1995, p. 69). The Manual also uses ISCO to identify occupations related to S&T activities. S&T activities cover a much larger spectrum than S&E fields do. However, in related terminology, groups of occupations have been identified to designate the S&E workforce, which are different from those established here. This variation is due to the underlying concept where the HRST and the STEM population are not equivalent, however much they may be closely related.

Box 10: OECD and Eurostat *Canberra Manual*: human resources devoted to S&T

As defined in the CM the human resources devoted to HRST consist of the two following groups: scientists and engineers, and technicians.

'According to UNESCO, individuals are classified as **scientists and engineers** if they have either [sic]:

i. completed education at the third level leading to an academic degree; or
ii. received third-level non-university education (or training) not leading to an academic degree but nationally recognized as qualifying for a professional career,
iii. received training, or acquired professional experience, that is nationally recognized as equivalent to one of the two preceding types of training (e.g. membership of a professional association or the holding of a professional certificate or licence)' (OECD & Eurostat, 1995, p. 69)

'**Technicians** are defined as personnel who have either:

i. completed the second stage of second level education. These studies are in many cases followed by one or two years' specialized technical studies, which may or may not lead to a diploma;
ii. received at least three years vocational or technical education (whether leading to a diploma or not) following completion of the first stage of second-level education;
iii. received on-the-job training (or acquired professional experience) that is nationally recognized as being equivalent to the levels of education defined under (i) or (ii) above.' (OECD & Eurostat, 1995, p. 70)

Using the basic definition of HRST from the CM, individuals meeting either of the following criteria qualify as belonging to the S&E workforce:

a. 'successfully completed education at the third level in an S&T field of study;
b. not formally qualified as above but employed in an S&T occupation where the above qualifications are normally required.' (OECD & Eurostat, 1995, p. 16)

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3. Monitoring STI policies towards gender equality

The SAGA tools support policy-makers and users in integrating, monitoring and evaluating gender equality in STI and in the design of gender-sensitive and evidence-based policies to strengthen the gender policy agenda.

As recommended by the European Union, 'building more consistent links between analysis and policy-making should be the main priority for research' and 'the persistence of inequalities requires a more comprehensive approach to policies for gender equality in science and research' (European Commission, 2012, p. 193). Furthermore, there is still limited availability of concrete methodology for evidence-based policy-making and for the monitoring of policies and operational instruments in STI focused on achieving gender equality in science. It is also essential to examine the mainstreaming of gender equality within STI public policies, as well as to map the planning, management and distribution of resources focused on the development of these policies.

In response to this, three tools have been developed in the framework of the SAGA project, in order to support policymakers and users in integrating, monitoring and evaluating gender equality in STI and in the design of gender-sensitive and evidence-based policies to strengthen the gender policy agenda:

- the STI Policy Survey;
- the SAGA Policy Matrix; and
- the STI Gender Equality Footprints.

3.1 The SAGA Survey of Gender Equality in STI Policies and Instruments

The STI Policy Survey collects information from national institutions, agencies and universities, based on the methodology described in SAGA Working Paper 3, and provides the main input to the SAGA Policy Matrix and the STI Gender Equality Footprints. The STI Policy Survey is a tool for gathering information on gender equality within policies in STI and follows the conceptual approach and methodology of UNESCO GO-SPIN (see Box 3), which enables the classification of information using the SAGA STI GOL (see Box 4). It collects information on different elements and gender equality components of the national STI system, such as:

- National and subnational STI policies and plans;
- National gender equality in STI policy;
- STI legal framework;
- Institutional framework for gender in STI;
- Objectives of the National Agency of Science and Technology;
- Existence of specific gender equality programmes or divisions;
- STI policy operational instruments;
- Plans, initiatives and measures that are being implemented by national research institutions.

The Survey addresses policies and policy instruments deliberately designed to promote gender equality in STI, as well as policies with indirect or differential effects on gender equality in STI.

The information produced by this survey will allow policy-makers, policy analysts and researchers to cluster policies, detect flaws in the policy mix, and establish an agenda for filling any gaps. The STI Policy Survey is intended for the use of national governments and policy-makers, responsible for gender-related and STI policies, who are interested in mapping the national STI system to improve gender equality policies and instruments or who want to make them more effective. Other users may include *inter alia*:

- Scientific and technological community and researchers;
- UN agencies, international governmental and non-governmental organizations;
- Civil society organizations; and
- The media.

The STI Policy Survey is described in detail in SAGA Working Paper 3, which also provides guidelines on how to adapt it to the particular characteristics of the country, as well as instructions for its implementation.

3.2 The SAGA Policy Matrix

The SAGA Policy Matrix provides a complete overview of STI plans, policies, policy instruments, legislation and regulations on gender equality in

STI, collected through the implementation of the STI Policy Survey. By establishing linkages with the SAGA STI GOL (see Box 4) it highlights potential gaps in the policy mix for gender equality in STI, subsequently supporting the drafting and priority setting of measures to improve it.

The SAGA Policy Matrix assists policy-makers and other stakeholders in evaluating the coverage of policies focused on promoting gender equality in STI, implemented by various institutions, as well as policies and policy instruments that have differential impact on gender equality (see section 2.3). The Matrix also identifies financial mechanisms and resources assigned to the implementation of the policies. It therefore helps in assessing and defining priorities, developing strategies and designing new policies to address the identified gaps, as well as develop a rational for adequate resource allocation, monitoring and evaluation. The Matrix will also provide information on the level of coordination and interactions among government institutions and key stakeholders. Therefore, it provides a basis for understanding constraints and opportunities for the countries in gender equality in STI.

In order to ensure ownership by all relevant stakeholders, it is essential to ensure a wide consultative process throughout the preparation of the SAGA Policy Matrix, particularly by identifying appropriate coordination, review and validation mechanisms.

The rows of the SAGA Policy Matrix are composed by the following elements, resulting from the different sections and sub-sections of the STI Policy Survey:

1. National/regional/local STI development plans;
2. National/regional/local STI policies;
3. Specific policies for Gender Equality in STI;
4. National/regional/local gender policies with STI components or STI impact;
5. Legal frameworks and regulations on STI;
6. Main constitutional documents of the national/regional/local STI promotion agencies;
7. Specific programmes or divisions of the STI Ministry or Agency, focused on gender equality in STI;
8. STI policy operational instruments implemented by the STI Ministry, Agency or other body, focused on gender equality in STI or with differential impact on gender. STI policy operational instruments are specific means used to implement policies. They respond to the question 'how' a particular policy is made effective to understand the means by which it is put into practice.

The columns of the Matrix reflect the particular characteristics of each of these elements, and allow for searches, integrations and gap-analysis. A minimum of such dimensions to include as columns are:

- **Name of the element.**
- **Institution implementing the policy or the instrument.**
- **Type and sub-type of element:** types of elements are the ones referred above (1 to 8). Sub-types depend on the element; in the case of STI policy operational instruments (type 8) these are described in Box 7.
- **SAGA STI GOL**: gender objectives at 2 digits level (i.e. including sub-objectives) to which the element contributes (see full list in Box 4). Please note that one element can address multiple objectives.
- **Beneficiaries:** types of beneficiaries targeted (see full list in Box 11).
- **Period of implementation** of the element: dates (year) of beginning and end of the implementation of the element.
- **Resources allocated** for the implementation of the instrument, for the last available year.
- **Geographical coverage:** local, subnational, national or regional.
- **Source of funding**:
    - government
    - business enterprise (public and private)
    - higher education
    - private non-profit organizations
    - foreign
- **SDG, target, indicator:** see Box 1 for an enumeration of the SDGs, and *https://sustainabledevelopment.un.org/* for their targets and indicators.

Table 7 shows a model SAGA Policy Matrix, listing a few examples of policies and instruments focused on achieving gender equality in STI. The number of columns in the SAGA Policy Matrix will depend on national needs and requirements, and it is possible to add other dimensions to the Matrix, not included in the list above, as a result of a customized STI Policy Survey.

Table 7. Example of the SAGA Policy Matrix

Name of the element	Institution	Instrument type[1]
'Agenda for the future'	Ministry of Science, Technology and Innovation	STI National Plan
STI Legal framework	Ministry of Science, Technology and Innovation	Legal framework
Gender equality in STI plan 2030	Ministry of Science, Technology and Innovation	Specific policies for Gender Equality in STI
Support for women students in choosing science courses (through fellowships, mentorship programmes, workshops etc.)	Ministry of Science, Technology and Innovation	B-C-D
Career advice and enrichment activities for students, encouraging women to pursue academic careers	Ministry of Education	B-C-D-E-M
Support system for women researchers by assigning managers, coordinators, and counsellors.	Ministry of Science, Technology and Innovation	E-I-N
Seminars on competing for funds to improve women's research skills	Ministry of Education	C
Scholarship extension during parental leave (including maternity, paternal and adoption leave)	Ministry of Welfare	I
Activities to raise awareness of the need to enable women to hold leading positions at research organizations	Ministry of Social Affairs and Employment	C-M-N
Support researchers returning to work after hiatus	NHRI	J-M-A
Child care facilities in the research institution	Ministry of Welfare	K-N
Enhance women's employability and entrepreneurial capacity	Ministry of Social Affairs and Employment	K-J-N
Support for women students in choosing science courses (through fellowships, mentorship programmes, workshops etc.)	Ministry of Science, Technology and Innovation	B-C-D

Note:

1 'Instrument type' (see Box 3) corresponds to the following categories: A – Technical Assistance; B – Scholarships/Fellowships; C – Training; D – Awards and Competitions; E – Creation and aid of technological poles and excellency centres; F – Donations (individuals/companies); G – Fairs; H – Trust; I – Financial Guaranty; J – Credit incentives and venture capital; K – Fiscal incentives; L – Loans; M – Information Services; N – Subsidy (non-reimbursable contributions).

2 Numbers in column 'STI gender objectives' correspond to gender sub-objectives as described in Box 4.

Overall, the SAGA Policy Matrix contributes to understanding the coverage of gender equality in the country's STI policies. In order to produce in-depth country analyses of gender in science, the Indicator Matrix (see Section 4) constitutes a complementary tool, adding specific indicators and data for monitoring and evaluation. The use of both matrices provides the necessary overview and is highly recommended.

STI gender objectives[2]							Beneficiaries[3]	Period of implementation	Resources allocated	Geographical coverage	Source of funding	SDGs
1. Social norms and stereotypes	2. Primary and secondary education	3. Higher education	4. Career progression	5. Research content, practice and agendas	6. Policy-making processes	7. Entrepreneurship and innovation						
			4					2015-2020		National	Government	9
		3.2		5.1	6.1			2002		National	Government	4-9
1.2			4.3					2015-2030		National	Government	17
	2.1	3.1					B-C-P-Q-R	2009-2014	150 000 Euros	Regional	Government	4
		3.1/3.2					P-B-C-Q	2009-	100 000 Euros	Regional	Higher Education	4-5
		3.1					R-A-D-V-Q	2011-2013	75 000 Euros	National	Government	5
			4.3				D-A-B-G	2011-2017	75 000 Euros	Local	Higher Education	5
			4.4				R-B-N	2014-	110 000 Euros	Regional	Government	5-8
			4.6				A-G-D-O-R	2011-	100 000 Euros	Local	Government	5-8
			4.4				Q-A-O	2015-	175 000 Euros	National	Government	8
			4.4				O-A	2014-	150 000 Euros	Local	Higher Education	4-8
						7.4	E-F-H-I-J	2013-	150 000 Euros	National	Government	5
			4.4				R	2015-	50 000 Euros	National	Higher Education	4-5

[3] 'Beneficiaries' (see Box 11) corresponds to the following categories: a – Research centres; b – Universities; c – Schools/Colleges/Institutes; d – Technical training centres; e – Public institutes; f – Professional institutes; g – STI public or private non-profit organizations; h – Private companies; i – Small and medium-sized companies; j – Cooperatives; k – Foundations; l – Local R&D groups; m – Ad hoc associations; n – University lecturers and researchers; o – Technical staff and assistants in STI; p – Students; q – Individuals; r – Women (exclusively); s – Indigenous peoples and local communities; t – Disabled people; u – Minorities; v – Professionals/Ph.D.s.

Box 11: Types of beneficiaries

Target groups/Beneficiaries. Select from the following list the corresponding items (one or more) which describe all the beneficiaries targeted by the policy instrument:

A. Research centres
B. Universities
C. Schools / Colleges / Institutes
D. Technical training centres
E. Public institutes
F. Professional institutes
G. STI public or private non-profit organizations
H. Private companies
I. Small and medium-sized companies
J. Cooperatives
K. Foundations
L. Local R&D groups
M. Ad hoc associations
N. University lecturers and researchers
O. Technical staff and assistants in STI
P. Students
Q. Individuals
R. Women (exclusively)
S. Indigenous peoples and local communities
T. Disabled people
U. Minorities
V. Professionals / Ph.D.s

3.3 The STI Gender Equality Footprints

The STI Gender Equality Footprints are tools to represent the profiles of gender equality in STI in a country. Each of the footprints, expressed as "spider" or "radar" charts, provides a graphic expression of the policies and instruments focused on gender equality in STI, based on qualitative and quantitative parameters, highlighting strengths and weaknesses of the country on the topic. The footprint allows for cross-national or temporal comparisons, and facilitates the identification of specific policy areas where gender equality initiatives can be strengthened.

Two STI Gender Equality Footprints are proposed, each with a different aim and list of parameters:

- STI Gender Equality Policy Footprint, and
- STI Gender Objectives Footprint.

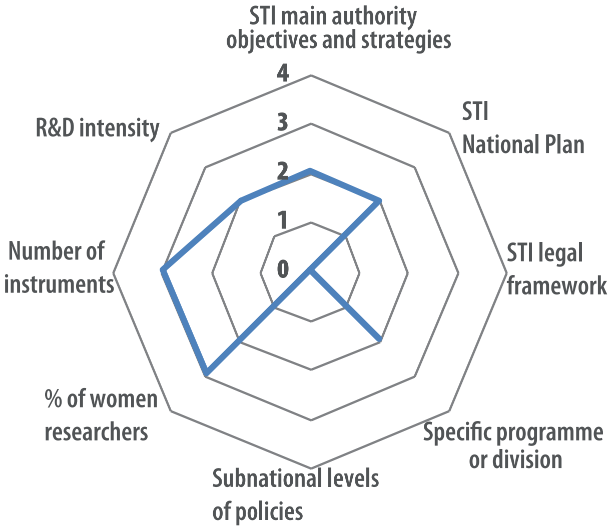
3.3.1: STI Gender Equality Policy Footprint

The STI Gender Equality Policy Footprint provides a graphic overview of the status of STI plans, policies, policy instruments, legislation and regulations on gender equality in STI. It helps in measuring the status of these parameters in a country, or the progress made in achieving them, by using the information collected through the implementation of the STI Policy Survey.

Figure 7 shows a model STI Gender Equality Policy Footprint. The parameters to include are listed below the figure.[6]

6. The values of each parameter go from 0 at the centre of the graph, to 4 at the outer ring. Higher values imply higher levels of development of the element.

Figure 7: Example of STI Gender Equality Footprint



1. **STI Ministry objectives:** quantifies the extent to which "gender equality in STI" is incorporated among the objectives and strategic vision of the highest STI authority in the country.
   - **0**= No mention
   - **2**= Brief mention
   - **4**= Included among the objectives or strategy of the STI main authority
2. **National STI Plan:** reflects the level of importance given to gender equality in the national STI plan.
   - **0**= No mention
   - **1**= Brief mention
   - **2**= Gender equality mentioned in various paragraphs
   - **3**= Section (second level) in a chapter, devoted to gender equality
   - **4**= Chapter (first level) devoted exclusively to gender equality
3. **STI legal framework:** reflects the extent to which gender equality in STI is incorporated in the legislation, such as specific laws or the national STI law.
   - **0**= No reference to gender equality in the legislation
   - **1**= No reference in the National STI Law, however, mention at the sub-national level
   - **2**= Reference only in the law which creates the STI Ministry or the National STI System
   - **3**= Chapter of the National STI Law devoted to gender equality
   - **4**= Specific legislation on gender equality in STI
4. **Specific programme or division:** reflects to which extent "gender equality in STI" has been the object of a specific programme or division in the Ministry responsible for STI.
   - **0**= No specific programme or division focused on gender equality in STI
   - **2**= A programme or division with wide priorities that include contributing to gender equality in STI
   - **4**= A specific programme or division devoted to gender equality in STI.
5. **Subnational level:** quantifies the extent to which "gender equality in STI" is present in STI policies or plans at the subnational level (departmental, regional, provincial, etc.).
   - **0**= No mention in subnational policies, or there are no subnational policies.
   - **4**= Subnational STI policies or plans incorporate gender equality in STI among their priorities or lines of action.
6. **Percentage of women researchers:** reflects the percentage of women in relation to the total number of researcher in the country, in headcounts.[7]
   - **0**= < 15 %
   - **1**= 15% - 24%
   - **2**= 25% - 34%
   - **3**= 35% - 44%
   - **4**= ≥45%
7. **Number of instruments:** reflects the number of existing STI policy and instruments focused on gender equality in STI in place in the country.
   - **0**= No instruments in place
   - **1**= 1 to 3 (low)
   - **2**= 4 to 6 (medium)
   - **3**= 7 to 9 (high)
   - **4**= ≥10 (very high)

7. Gender parity is considered to be within the 45%-55%. Please note that more than 55% is not considered as parity. See Section 2.1 for the definition of gender parity.

Source: http://www.un.org/sustainabledevelopment/

8. **R&D intensity:** expenditure in R&D as a percentage of GDP.
   - **0**= ≤0.09%
   - **1**= 0.1%-0.25%
   - **2**= 0.26%-0.55%
   - **3**= 0.56%-0.85%
   - **4**= ≥0.85%

3.3.2 STI Gender Objectives Footprint

The STI Gender Objectives Footprint provides a graphic overview of the status of each of the seven objectives of the SAGA STI GOL (described in box 4) in a country, or the progress made in achieving them, by using the information collected through the implementation of the STI Policy Survey.

Figure 8: Example of STI Gender Objectives Footprint

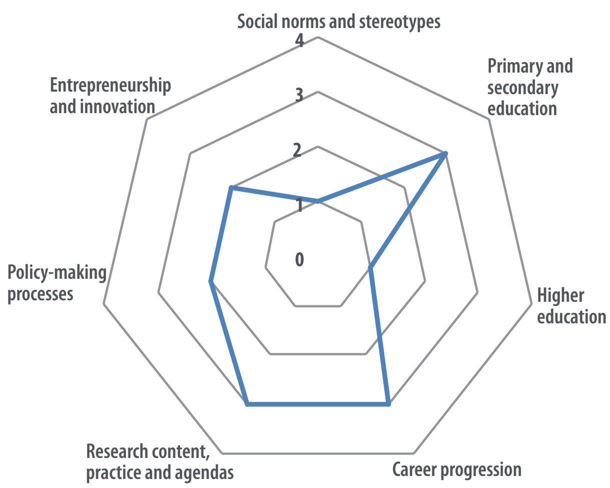


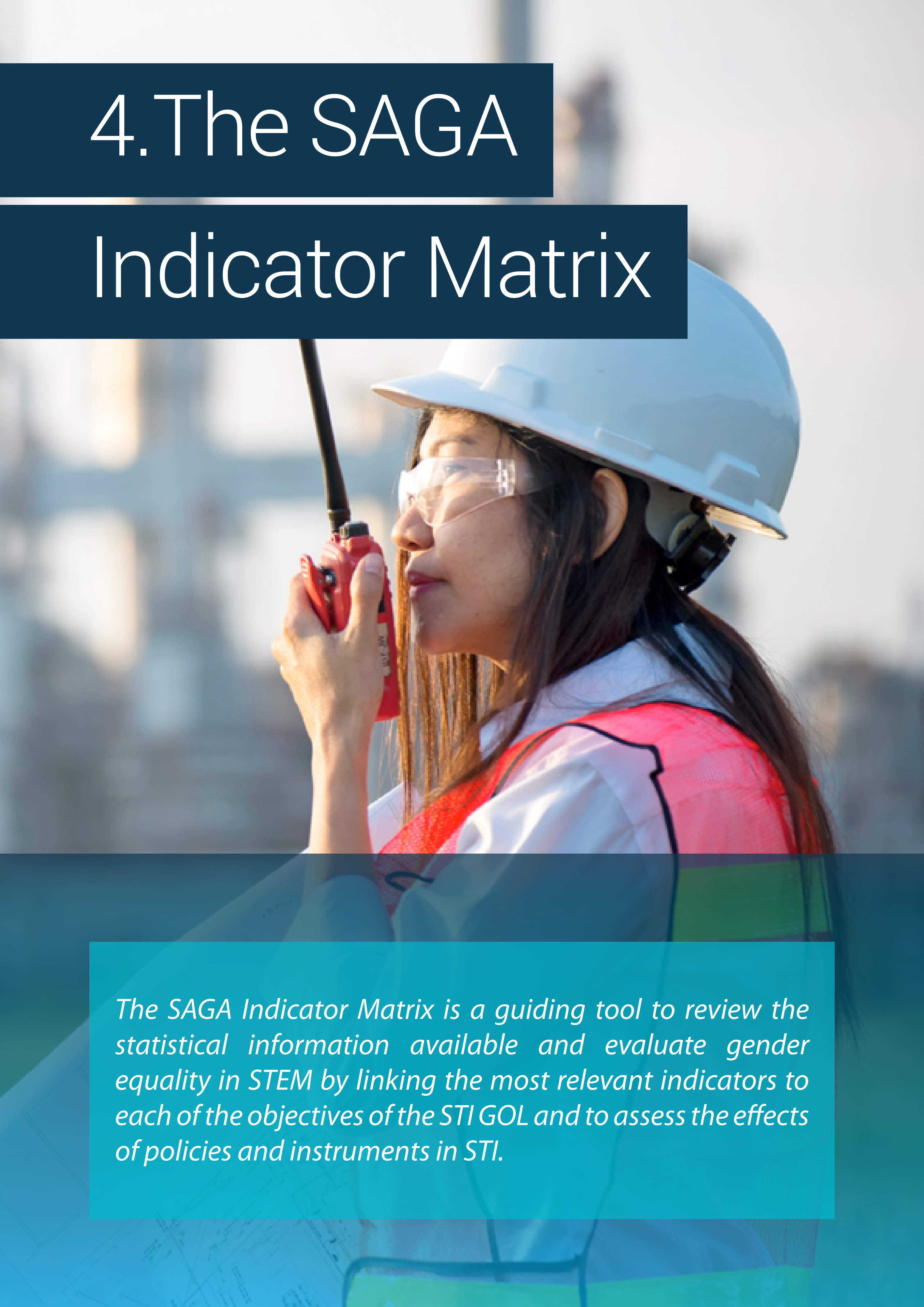
Figure 9 shows a model STI Gender Objectives Footprint. The values of each parameter are based on the following criteria.[8]

- **0**= No instruments in place
- **1**= 1 to 3 (low)
- **2**= 4 to 6 (medium)
- **3**= 7 to 9 (high)
- **4**= ≥10 (very high)

8. The values of each parameter go from 0 at the centre of the graph, to 4 at the outer ring. Higher values imply higher levels of development of the element.

1. **Social norms and stereotypes:** reflects the number of existing STI policies and instruments aimed at changing perceptions, attitudes, behaviours, social norms and stereotypes towards women in STEM in society in place in the country.
2. **Primary and secondary education:** reflects the number of existing STI policies and instruments aimed at engaging girls and young women in STEM primary and secondary education, as well as in technical and vocational education and training in place in the country.
3. **Higher education:** reflects the number of existing STI policies and instruments aimed at attracting and retaining women in STEM higher education at all levels in place in the country.
4. **Career progression:** reflects the number of existing STI policies and instruments focused on gender equality in career progression for scientists and engineers (S&E) in place in the country.
5. **Research content, practice and agendas:** reflects the number of existing STI policies and instruments aimed at promoting the gender dimension in research content, practice and agendas in place in the country.
6. **Policy-making:** reflects the number of existing STI policies and instruments aimed at promoting gender equality in STEM-related policy-making in place in the country.
7. **Entrepreneurship and innovation:** reflects the number of existing STI policies and instruments aimed at promoting gender equality in science and technology-based entrepreneurship and innovation activities in place in the country.

4. The SAGA Indicator Matrix



The SAGA Indicator Matrix is a guiding tool to review the statistical information available and evaluate gender equality in STEM by linking the most relevant indicators to each of the objectives of the STI GOL and to assess the effects of policies and instruments in STI.

The SAGA Indicator Matrix is a guiding tool to review the statistical information available and evaluate gender equality in STEM by linking the most relevant indicators to each of the objectives of the STI GOL to assess the effects of policies and instruments in STI for the promotion of gender equality. The selected indicators presented in the Indicator Matrix represent lead indicators and do not represent an extensive list of all possible indicators.

The Indicator Matrix should be used to review the information needed to assess the evidence in the evaluation of policies and instruments in promoting gender equality in STI. In the Indicator Matrix, leading indicators, in terms of their informative potential, are listed. They are also linked to gender objectives of the STI GOL (see Section 3.4) to help in the review of the existing information coverage and identify gaps in evidence. In addition, sources for each indicator are also suggested to help locate the data. The list of indicators is not exhaustive and will be updated on an *ad hoc* basis as activities in pilot countries are completed and tools are refined.

The majority of the indicators listed in Table 9 are generally generated using aggregated data and give sufficient information to evaluate gender equality in various contexts. In fact, when an existing system to manage the information is in place, little or no manipulation of the data may be necessary to produce indicators. Alternatively, the information may not be easily accessible or available, in which case a methodology and guidelines for working with these sources and the data is found in Section 5 of this Toolkit.[9] Lastly, for some gender objectives of the STI GOL, individual-level data is needed to better understand the determinants and factors related to given situations and contexts. The SAGA D&B Survey has been developed to enable the collection of information on these objectives. The survey is introduced in Section 5.1 and is the object of SAGA D&B Survey (Working Paper 4).

Researchers and reviewers should use the Indicator Matrix to review either i) which gender objective the information they have access to can inform or, alternatively, ii) which indicator may be use to inform on a given objective. This is possible because of the Matrix structure; the Indicator Matrix has, on the left side, a list of numbered indicators and on the right side, the seven gender objectives of the STI GOL. Each of the indicators are then associated with the gender objective(s) to which they can be used as evidence. An indicator can inform on more than one of the gender objectives. In addition, suggestions of data sources to either find a given indicator, or which source of information to use to create the indicator is found below each one. Guidelines on how to work with the various indicator sources and related recommendations on how to improve their informative potential are given in Section 5 and will be further developed as these sources are fully integrated into the SAGA approach.

9. Note: the methodology and guidelines for working with the data sources in Section 5 are under development as the tools and the various sources are being piloted in countries, regions, institutions, and organisations..

Table 8. SAGA Indicator Matrix

	Indicators	STI gender objectives						
		1	2	3	4	5	6	7
		Social norms and stereotypes	Primary and secondary education	Higher education	Career progression	Research content, practice and agendas	Policy-making processes	Entrepreneuship and innovation
1	Total and share of women researchers by • seniority grades • age • FORD (broad and narrow) Source: R&D data				X			
2	Total and share of women in top-level positions in • governments • business enterprises • universities • research performing institutions • financing organizations • academies, assemblies and councils • (governing) boards • commissions • foundations Source: Institution review of committees or personnel, academies and professional associations, SAGA Survey of Drivers and Barriers			X	X		X	X
3	Total and share of women on committees, including • admission committees • recruitment committees • performance evaluation committees • proposal evaluation panels • advisory committees • expert groups or panels • peer review committees • scientific boards (of academies, societies, and universities) • principal investigators on projects • team members on projects Source: Academies and professional associations, SAGA D&B Surveys, institutional review of committee composition				X			
4	Total and share of female teachers by • subject (in science) • type of institution (private, public) • educational level (primary, secondary, TVET) Source: National education data		X					
5	Total and share of female students by • age • field of study • level of education (ISCED) • by classroom (ratio of female students to teacher) Source: National education data			X				
6	Total and share of female applicants to university by • field of study (broad and especially narrow – STEM fields) • educational levels Source: National education data			X				
7	Total and share of women accepted to university programmes by • field of study (broad and especially narrow – STEM fields) • educational level Source: National education data			X				

	Indicators	STI gender objectives						
		1	2	3	4	5	6	7
		Social norms and stereotypes	Primary and secondary education	Higher education	Career progression	Research content, practice and agendas	Policy-making processes	Entrepreneuship and innovation
8	Total and share of women enrolled in university programmes by • field of study (broad and especially narrow – STEM fields) • educational level Source: National education data			X				
9	Total and share of female graduates from university programmes by • field of study (broad and especially narrow – STEM fields) • educational level Source: National education data			X				
10	Total and share of women nominated for scholarships and awards by • field of study • field of research • educational level • country of origin, nationality • country of diploma awarded Source: National research funding agencies			X	X			
11	Total and share of female applicants to scholarships and awards by • field of study • field of research • educational level • country of origin, nationality • country of diploma awarded Source: National research funding agencies			X	X			
12	Total and share of female recipients of scholarships and awards by • field of study • field of research • educational level • country of origin, nationality • country of diploma awarded Source: National research funding agencies			X	X			
13	Total and share of women with tertiary education by • age (age groups, especially for age groups at average graduation age) • field of study (broad and narrow) Source: Population-based surveys (census, labour force surveys, etc.)			X				
14	Total and share of reported events of discrimination by • sex of reporter • education level • field of study or educational programme Source: Ombudsperson office or similar[1], SAGA D&B Survey			X	X			
15	Total and share of reported events of harassment by • sex of reporter • education level • field of study or educational programme Source: Ombudsperson office or similar[1], SAGA D&B Survey			X	X			
16	Total and share of female applicants to funding for international mobility Source: National research funding agencies			X	X			
17	Total and share of female recipients to funding for international mobility Source: National research funding agencies			X	X			
18	Total and share of female participants to international mobility programmes Source: National research funding agencies			X	X			
19	Total and share of female applicants for re-entry grants after career breaks Source: National research funding agencies			X	X			

	Indicators	STI gender objectives						
		1 Social norms and stereotypes	2 Primary and secondary education	3 Higher education	4 Career progression	5 Research content, practice and agendas	6 Policy-making processes	7 Entrepreneuship and innovation
20	Total and share of female recipients for re-entry grants after career breaks Source: National research funding agencies			X	X			
21	Personal use of day and child care facilities Source: SAGA Survey of Drivers and Barriers			X	X			
22	Total and share of female workers in S&E occupations Source: National statistics office (including labour force surveys)			X	X			
23	Total and share of women with tertiary education and employed as professionals or technicians (S&E occupations) as a percentage of tertiary educated people Source: National statistics office, population-based surveys (including labour force surveys)			X	X			
24	Gross annual earnings by • sex • field of R&D • occupation • economic activity (e.g. NACE[2]) Source: National statistics office, revenue office, population based surveys			X	X			X
25	Total and share of female applicants for engineering certification Source: National engineering accreditation authority				X			
26	Total and share of female recipients of engineering certification Source: National engineering accreditation authority				X			
27	Distribution of hours spent doing: • research • teaching • administrative tasks by • sex • field of R&D • occupation • full-time/part-time or equivalent by research institution Source: Time-use surveys, SAGA D&B Survey				X	X		
28	Total and share of women listed as first author[3] by • country of origin • field of research (broad and narrow) Source: Bibliometrics				X			
29	Total and share of women who reported the use of or existence of code of conduct (and procedures of application) Source: SAGA D&B Survey			X	X			
30	Total and share of female speakers invited for • trainings • conferences • panels • workshops Source: Academies and professional associations, SAGA D&B Survey	X	X	X	X		X	
31	Total and share of female participants in • trainings • conferences • panels • workshops Source: Academies and professional associations, SAGA D&B Survey	X		X	X		X	
32	Total and share of women who are members of professional associations Source: Academies and professional associations, SAGA D&B Survey			X	X			

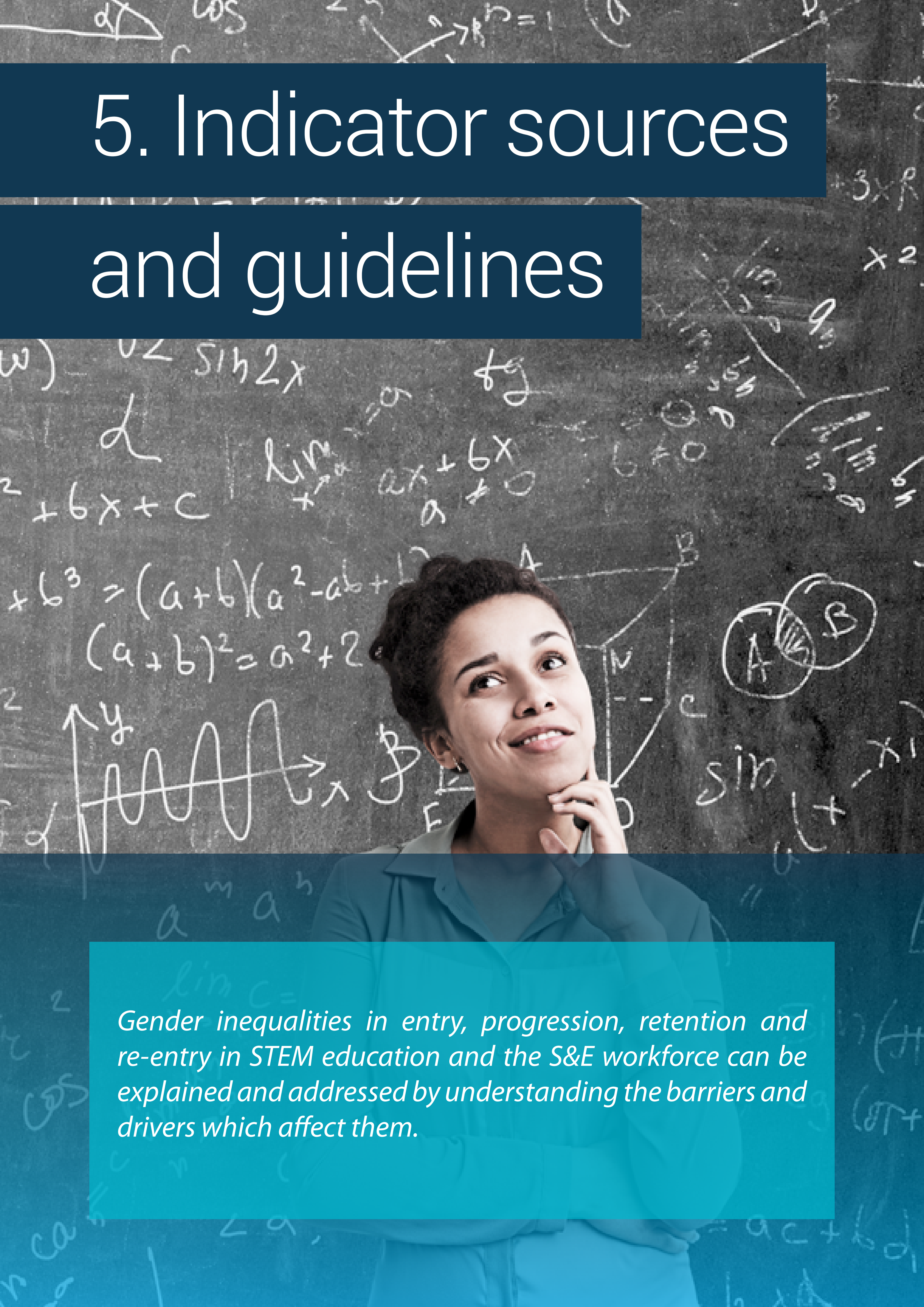
	Indicators	STI gender objectives						
		1	2	3	4	5	6	7
		Social norms and stereotypes	Primary and secondary education	Higher education	Career progression	Research content, practice and agendas	Policy-making processes	Entrepreneuship and innovation
33	Women as percentage of members of national science academies, by individual academy by broad discipline, expressed as mean and median shares respectively Source: Academies and professional associations				X			
34	Women as percentage of members of global science academies, by individual academy Source: Academies and professional associations				X			
35	Women as percentage of members serving on the governing body, by national academy Source: Academies and professional associations				X			
36	Total and share of women as speakers and participants invited or selected for training, conferences, panels and workshops (review of speakers-participants list) Source: Academies and professional associations				X			
37	Percentage of national academies with a women as president or chair by academy type Source: Academies and professional associations				X			
38	Existence of a gender policy or any document (strategy, policy, founding document, etc.) that explicitly mentions the need for increased participation by women in the academy's activities Source: Academies and professional associations						X	
39	Surveyed national academies that present a special award for women, and how often the award is presented Source: Academies and professional associations				X			
40	Percentage in agreement with statements about the participation of women in the national academy's activities Source: Academies and professional associations, attitudes and perception surveys	X						
41	Existence of a committee that addresses gender or diversity issues or anyone advising the academy on gender or diversity issues Source: Academies and professional associations				X			
42	Total and share of women as listed inventors by • country of origin of inventor • technological fields • sector (academia and business) Source: Intellectual Property data (WIPO or national source)							X
43	Total and share of patent applications with at least one woman as listed inventor by • country of origin of first applicant • technological fields • sector (academia and business) Source: Intellectual Property data (WIPO or national source)							X
44	Total and share of patent applications with only women as listed as inventors by • country of origin of first applicant • technological fields • sector (academia and business) Source: Intellectual Property data (WIPO or national source)							X
45	Proportion of a country's scientific publications integrating a gender dimension in their subject matter by field Source: Web of Science					X		

[1]. The terminology is just an example of a wide variety of possibilities in different countries or institutions.

[2]. NACE stands for 'nomenclature statistique des activités économiques dans la Communauté européenne', a Statistical Classification of Economic Activities in the European Community.

[3]. This Toolkit refers to 'first author' as the person who has undertaken the research work. Please note that it might also be indicated as the 'corresponding author'.

5. Indicator sources and guidelines



Gender inequalities in entry, progression, retention and re-entry in STEM education and the S&E workforce can be explained and addressed by understanding the barriers and drivers which affect them.

Access to information on STEM education and S&E careers disaggregated by sex is instrumental in assisting policy-makers in the evaluation of gender policies in STI and in setting in place instruments aimed at reducing gender gaps in STEM. Many sources of information, updated on a relatively regular basis and with great potential for informing, tend to be underused as evidence and in assessing policy impacts. The richness of these sources can reach full potential by simply expanding the scope and the granularity of the data collected. In fact, the addition of variables or higher precision in the classifications could provide more relevant information for STI policy assessment. For other sources of information, such as academy and association databases and funding agency records, a more complete review of the information requested from members or applicants is recommended and guidelines are suggested here in this section to achieve this.

This section is organised by the different types of sources where the indicators from the Indicator Matrix can be found. These sources are introduced and, for some, recommendations on how to fully benefit from them are given. Detailed methodological guidelines on how to increase the potential of these sources based on the recommendations are provided as annexes and in SAGA D&B Survey (Working Paper 4), available online. These types of sources include:

- A bried overview of the SAGA D&B Survey (Working Paper 4)
- Education data sources
- Population-based surveys (censuses, labour force surveys, etc.)
- R&D surveys
- Surveys of advanced qualification holders
- Research funding agencies
- Academies, professional associations and professional accreditation offices
- Intellectual property (IP) data
- Bibliometrics

5.1 The SAGA Survey of Drivers and Barriers to Careers in Science and Engineering

Gender inequalities in entry, progression, retention and re-entry in STEM education and the S&E workforce can be explained and addressed by understanding the barriers and drivers that affect them. While some aspects of pursuing an education in STEM or of joining the S&E workforce may deter some women, other factors may act as driving forces. These drivers and barriers may apply to men as well, given that they are underrepresented in some subfields. The distribution of women and men by field varies across countries and regions as it largely depends on cultural contexts. However, to evaluate the effects of these factors on men and women's participation to STEM, evidence must be available to provide a reliable and complete picture of the situation.

Drivers and barriers to a future in STEM can be encountered at any point in time – from childhood to senior years in S&E careers – and they may take a variety of forms; some may be more influential at an early or later stage of life than others. For example, women may be prevented from choosing to pursue an education in STEM and, subsequently, to start a career as a scientist or an engineer, despite their potential, because of barriers encountered throughout their life. Therefore, factors considered as drivers and barriers are important when working towards the promotion of gender equality in STEM.

Drivers and barriers range from implicit gender biases in the society, which can be detected in attitudes, perceptions and behaviours of individuals towards women in science, in the educational and professional environment, in work conditions and policies, in opportunities for career development and progression (a phenomenon known as the glass ceiling when women are unable to reach higher professional positions), in networking and funding opportunities, in direct and indirect discrimination and harassment, etc. Achieving a healthy balance between work and personal life can also be challenging in a highly competitive environment and discourage some individuals from continuing on and progressing to the different stages of S&E careers.

The D&B Survey has been developed in close conjunction with the STI GOL to assist in the collection of information on drivers and barriers to careers in S&E. This information is often not available from national sources. Therefore, this new instrument will enable key actors to better understand the roles and the magnitude of the different drivers and barriers commonly identified to explain the gender imbalance in STEM.

The D&B Survey consists of short modules on experiences during higher education and training to the transition to and participation in the S&E workforce. In addition, the survey also covers all drivers and barriers highlighted in the STI GOL, ranging from the work environment, access to funding opportunities, professional recognition and awards, work-life balance experience, discrimination and harassment, role models, and attitudes and social norms on gender and S&E. These themes are divided into several modules to facilitate the customization of the survey and to better address national priorities in STI policies. The modules are:

- **Personal characteristics**: for basic demographic information on survey respondents.
- **Education background**: collects information on the educational history of respondents.
- **Education experience**: for information on respondents experience, such as the drivers and motivators behind their choice of field of study and experience which encouraged or prevented individuals to complete an education in STEM.
- **Postgraduate experience**: for information on postgraduate fellowships, including experience with mentor, type of work involved in position, and satisfaction.
- **Employment experience**: collects information to better understand respondents' employment status (both current and past) in addition to work opportunities and satisfaction.
- **Work policies and practices**: surveys the policies and practices at respondents' place of work, ranging from existence of equal pay policies, to childcare contributions and infrastructure.
- **Career break**: questions on interruption from work for a period of six months or longer to capture reason(s) of absence and reintegration in the workplace upon return.
- **Funding**: collects information on funding applications and success.
- **Professional recognition and awards**: section on professional experiences on committees and other positions with professional recognition. It also collects information on participation in STI policy drafting, councils, and as STI experts and on articles, patents, applications and awards.
- **Time use**: module dedicated to academics and collecting information on time allocated to teaching, research and administrative task at different period of academic year.
- **Work-life balance**: information on the balance and equal distribution between work and personal life responsibilities.
- **Discrimination and harassment**: probes experience of discrimination in obtaining a promotion or a position, in the recognition of achievements, but also day-to-day work-related exchanges, and of harassment of all types are investigated. This includes micro and subtle forms of discrimination, such as demeaning comments, not listening to women's contributions in meetings, and different sorts of double standards.
- **Attitudes and social norms**: captures general attitudes and views on men and women's right to participate to science activities and careers.
- **Role models**: People play an important role in shaping one's career. These individuals may have supported, trained, provided advice or endorsed respondents in their career development. This short module seeks to identify who motivated respondents' career choice.

The D&B Survey refers to the STEM population as defined in Section 2.5 as the target population. In fact, the versatility of the survey application represents an advantage as it will be adaptable to the different situations present across the world. For practical purposes, the surveyed population may be people with a STEM education, those who are part of the S&E workforce, or a subset of either. The survey instrument can also be adapted to target any other related population of interest. In fact, it can be used for a population at large or be conducted within an institution for a subpopulation such as currently enrolled students or faculty. This also means that there is a need to cautiously adapt the survey prior to its implementation to ensure high quality data. Instructions on how to adapt and conduct the survey are provided in SAGA D&B Survey (Working Paper 4).

5.2 Education data sources

National offices such as governmental departments responsible for national education usually keep track of information on the body of students and educators and teaching material. Such information has great potential to provide evidence on the distribution of women and men involved at multiple levels of education in science, as well as on curricular material.

UIS, along with OECD and Eurostat, collects internationally comparable data for the evaluation and monitoring of education systems around the world and the Survey of Formal Education enables the collection of data on access, participation, progression and completion, as well as human resources in formal education (UNESCO-UIS, 2016). This survey has several components on specific levels of education, such as the survey of students and graduates in tertiary education programmes, from which it is possible to assess the enrolment in specific programmes as well as the progression through the attainment of educational levels for both men and women. Some information is also collected on teachers in lower levels of education as part of this survey.

National sources should however have access to more detailed information than what is provided to international organizations such as UIS or the European Commission. In fact, it is recommended to collect and organize the information at the national level at the highest level of detail possible, in order to draw maximum information from the data.

The review of data on education for assessing gender equality in STEM is separated into three sections: information on students (at the primary, secondary and tertiary education levels), teachers, and curricula and the learning environment. Recommendations on how to use the data to evaluate gender equality in science are presented for each section, along with a list of the main indicators listed in the SAGA Indicators Matrix (see Section 4).

Students

To review all levels of education for students, data should be reviewed for primary, secondary and tertiary education levels.

Primary and secondary education levels

At the primary and secondary education levels, mathematics and (pure and applied) sciences are generally the main STEM-related subjects of the curriculum, and lay the foundation for future training in science. From the primary and secondary education standpoint, the assessment of gender parity in science can be completed by looking at the ratio of boys and girls in science classes, although it may be difficult due to how teaching material is delivered at lower levels of education. In fact, mathematics and science classes are usually integrated into the general curriculum, and it may be difficult to separate these classes from the general curriculum. As a result, the best way to assess boys' and girls' achievements and views over men and women in STEM, can be through performance evaluation and, when possible, with attitude and perception surveys.

1. Review of student's learning outcomes in mathematics and science

In most countries, a final (national) examination of students' attainment of knowledge, skills, and aptitudes is conducted. From this examination, a review of students' performance (using average marks, for example) by sex can reveal if there are disparities in learning outcomes between boys and girls in mathematics and science.

2. Review of student perceptions and attitudes on mathematics and science

An assessment of students' attitudes and perceptions of mathematics and science are insightful to learn how stereotypes and social norms may be affecting career choices of girls and boys.

3. Review of student access to labs or science teaching materials to provide hands-on training

Students' access to labs and science teaching material provides them with hands-on training and introduces them to science in a more realistic and stimulating manner. This has been shown to stimulate students' interest in science and promote careers in S&E.

Internationally, the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) are two assessment surveys of student achievement in science and mathematics in grade 4 and grade 8 for TIMSS and at age 15 for PISA. Other institutional, regional, or national assessments may also exist and provide a source of information or a model to look into for the assessment of student achievements.

Example of indicators on students at primary and secondary level of education

#	Indicators
5	Total and share of female students by • age • fields of study • level of education (ISCED) • by classroom (ratio to teacher)

corresponds to the number of the indicator in the SAGA Indicators Matrix (see Section 4).

Useful documentation:

- Programme for International Student Assessment (PISA)
- International Association for the Evaluation of Educational Achievement (IEA):
  - Trends in International Mathematics and Science Study (TIMSS)
  - TIMSS Advanced
  - International Computer and Information Literacy Study (ICILS)
- Programme d'analyse des systèmes éducatifs de la CONFEMEN (PASEC)
- Third Regional Comparative and Explanatory Study (TERCE)
- The Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ)
- *A Complex Formula: Girls and Women in Science, Technology, Engineering and Mathematics in Asia (UNESCO, 2015a)*
- *Cracking the code: girls' and women's education in STEM* (UNESCO, 2017).

Tertiary education level

An assessment of STEM education at the tertiary level is more easily done due to the availability of data and the granularity of fields of study in science, which improves the evaluation of the distribution of men and women in STEM fields.

1. Review of number of applicants by sex and detailed fields of education in tertiary educational programmes

At the institutional level, it may be possible to review the number of applications received (and applicants accepted) in STEM programmes by field of study and sex.

2. Review of number of students enrolled by sex and detailed fields of education in tertiary programmes in STEM

Information on female to male applicants in parallel with enrolment, can show differences in the number of women and men submitting applications to STEM programmes and trends in student admission.

3. Review of number of first-time new entrants to tertiary education[10]

With the implementation of new policies designed to attract more women to STEM programmes, it is important for policy-makers to evaluate and monitor the success of these measures. Monitoring the number of students in first year of STEM programmes by sex over time will provide insight on the effects of new measures aimed at attracting more women to STEM programmes. The number of students enrolled in general shows an inflated picture of students entering a tertiary programme for the first time. Thus, contrasting newly enrolled students from all students within a programme is recommended to evaluate if there is an increase in the number of students enrolled in specific programmes, which could be related to new policies set to attract women to STEM programmes.

Templates of output tables based on the UIS Survey of Formal Education are provided to show how to present the information and produce indicators in Annex 1. Note that the data for these tables should be collected from the authorities overseeing education at the national level or registration office, for example, at the institutional level, for men and women separately in order to produce sex-disaggregated statistics and assess gender equality in STEM education.

4. Review of number of graduates by sex and detailed fields of education in tertiary programmes in STEM

While the general distribution of education by sex can provide information on the differences between men and women in education, it can also easily hide variations when examined more closely. Table 9 shows the percentage of female graduates at higher education levels (ISCED 5-6) in the field and subfields of science by region for 2008. For example, the 51% of women in the broad field of science in the Arab States depicts a situation where women and men seem to both be equally graduating in science. However, the distribution at the subfields shows a different situation as women represent only 33% of all graduates in computing but 73% in life sciences. This distribution is similar in other regions of the world.

Table 9. Percentage of female graduates at ISCED 5 and 6 levels in the fields of science by region, 2008

Regions	Broad field of science	Subfields of science			
		Life sciences	Physical sciences	Mathematics and statistics	Computing
Arab States	**51**	73	61	59	33
Central and Eastern Europe	**47**	70	54	53	29
Central Asia	**53**	68	44	60	39
East Asia and the Pacific	**48**	60	58	62	29
Latin America and the Caribbean	**41**	67	51	53	31
North America and Western Europe	**40**	60	43	48	21

Source: Global Education Digest 2010. Comparing Education Statistics Across the World. UIS, 2010.

For access to information similar to that in Table 9, the number of students and graduates by detailed fields of science is essential to assess the distribution of women and men in specific science fields.

Examples of indicators on tertiary level of education	
#	Indicators
6	Total and share of female applicants to university by • field of study (broad and especially narrow – STEM fields) • educational level
7	Total and share of women accepted to university programmes by • field of study (broad and especially narrow – STEM fields) • educational level
8	Total and share of women enrolled in university programmes by • field of study (broad and especially narrow – STEM fields) • educational level
9	Total and share of female graduates from university programmes by • field of study (broad and especially narrow – STEM fields) • educational level

corresponds to the number of the indicator in the SAGA Indicators Matrix (see Section 4).

10. First-time new entrants to tertiary education are students who have not previously been enrolled in any other programme at the tertiary level (UNESCO-UIS, 2016).

Teachers

Teachers play an important role as models for students at all levels of education. Information on the number of teachers by subject and grade should be available from the government department responsible for education and educational institutions.

1. The collection of the number of teachers by sex, teaching level of education and fields of study and type of institution (public vs. private) when applicable

Examples of teacher-related indicators

#	Indicators
4	Total and share of female teachers by: • teaching level of education • field of study • type of institution (private, public) Access to this information will enable production of the following indicators, among others: • Percentage female science teachers at teaching level of education • Ratio of female to male teachers in science at teaching level of education

corresponds to the number of the indicator in the SAGA Indicators Matrix (see Section 4).

Curricula and learning environment

Mainstreaming gender effectively into curricula can contribute to raise awareness about women's experience and increase women's participation in science by bringing a gender lens to how material is presented to students. Since curricula are designed to link national education policy objectives with the education provided to students, they can have a powerful impact. By replicating existing gender stereotypes that limit women's participation in STEM and not taking into account the differences in learning between boys and girls, curricula can reinforce existing gender inequalities. Teaching material can also convey a positive and equal image of both girls and boys, and women and men in STEM. Curricula should be reviewed to ensure there is no gender stereotyping in teaching materials.

Useful documentation:

- UNESCO- IBE, 2013, Training Tools for Curriculum Development - A Resource Pack. (UNESCO-IBE, 2013).
- TIMSS Encyclopedia (Mullis, et al., 2016).

5.3 Population-based surveys

Information on national populations and specific subpopulations collected through censuses and administrative data provides access to evidence to assess gender equality. Population-based surveys are a source of information on employment, time-use, and social norms and stereotypes of women and men in science. National statistics offices may also conduct, either on a regular or on an *ad hoc* basis, surveys on specific topics for national needs. For example, labour force surveys have great potential to inform on the participation of women to the labour force and characteristics can be linked to information collected by national censuses.

The indicators produced using population-based surveys vary from employment, to time-use, to attitudinal. Considering this, the recommendations are presented by the types of surveys.

Labour force surveys

1. Review of distribution of women and men by S&E occupation

With the distribution of men and women in S&E occupations, it is possible to know the representation of men and women in these occupations and, if the information is available over time, to observe any trends in the relative number and proportion of men and women in them. Employment distribution by sex and by occupations to isolate S&E variants using ISCO-08 should be defined at a detailed level as recommended in Section 2.5.2.

The degree of success in transitioning to the workforce can be assessed by using data on labour force status and educational attainment by age and sex. Ideally, the field of education and the type of occupation would also be accessible in order to determine if STEM educated individuals manage to find employment in their trained field.

Examples of employment and participation to labour force indicators	
#	Indicators
23	Total and share of women with tertiary education and employed as professionals or technicians (S&E occupations) as percentage of tertiary educated people
24	Gross annual earnings, by sex, age and occupation (detailed)

corresponds to the number of the indicator in the SAGA Indicators Matrix (see Section 4).

Time-use surveys

Time-use surveys collect information on activities related to a variety of themes, including domestic chores and recreation activities, among others, which help to better understand how individuals manage their time.

1. Review of distribution of time used by sex

The distribution of time used to provide unpaid care to dependents and to do domestic chores and recreational activities can reveal gaps between men and women in how their time is allocated. In most instances, the information collected on different activities is not at a detailed enough level to draw conclusions and thus, attention should be given in the review and analysis of these data.

Attitudes and perception surveys

Surveys on attitudes can be useful to evaluate respondents' perception of women in science and thereby be in a better position to promote awareness and overcome non conscious and cultural gender biases. Generally, public opinion surveys are used to sense how the public may feel regarding specific issues and are then used as a barometer of the effectiveness of policies or any other specific topic.

5.4 Research and experimental development surveys

R&D surveys represent one of the main sources of information on R&D personnel, an important subset of the S&E workforce. To draw the full potential from R&D data, a variety of breakdowns are needed in classifying R&D personnel. The following recommendations are suggested to increase the information from this source as the data are collected and reported.

The FM sets guidelines for measuring R&D for different sectors of activity by personnel and expenditures and defines three groups of R&D personnel: researchers, technicians and equivalent staff, and other support staff (OECD, 2015b). Based on the nature of their tasks (and not on job position), only researchers, along with technicians and equivalent staff, are considered a subset of the S&E workforce as defined as the STEM population is defined in this Toolkit.[11] Therefore, only these two groups should be included in the statistics from R&D reported in reference to the STEM population.

The UIS has developed the *Guide for Conducting an R&D Survey: For countries starting to measure research and experimental development* (UNESCO-UIS, 2014a), which presents relevant R&D indicators, discusses the main issues facing each of the major sectors of performance, provides a simple project management template, and proposes generic model questionnaires for the government, higher education, business and private non-profit sectors. This guide follows the FM recommendations and the measurement of R&D personnel in terms of headcount (HC) and full-time equivalent (FTE) data. 'The HC of R&D personnel is defined as the total number of individuals contributing to intramural R&D, at the level of statistical unit or at an aggregate level, during a specific reference period (usually a calendar year).' FM §5.58 'The FTE of R&D personnel is defined as the ratio of working hours actually spent on R&D during a specific reference period (usually a calendar year) divided by the number

11. For more detailed information on the FM, refer to Section 2.5.1.

of total number of hours conventionally worked in the same period by an individual or a group.' FM §5.49

Based on these guidelines and to extract as much information as possible on researchers in STEM fields from R&D surveys, the SAGA project has the following three recommendations on R&D data.

1. Collect information on researchers and technicians by sex and broad field of R&D at the first and at the second level of detail for the fields of R&D

R&D surveys generally already collect data for men and women separately. This attribute is highly valuable as it enables clear identification of the differences in participation of female and male researchers by educational attainment, age, and field of R&D. To better understand the distribution in specific fields in which fewer women participate, it is important to be able to identify disparities between the different subfields. However, the information is rarely reported at the required level of specificity to allow the observation of the distribution for all fields. In the above-mentioned UIS Guide and based on SAGA's definition of STEM population, tables for HC of all R&D personnel according to two personnel categories (researchers, technicians and other support staff) and fields of R&D are suggested as part of an R&D survey for all sectors.

2. Collect information on researchers by sex and seniority grade

In the 2015 update of the FM, seniority grades have been included in the recommended measurement of R&D personnel.[12] Data on seniority of researchers can offer increased information on career access and progress and should therefore be collected to evaluate the presence or absence of any glass ceiling.

3. Collect information on researchers and technicians by sex and age

Career progression is strongly related to age among other sociodemographic characteristics, as one tends to reach higher grades over time. Therefore, it is relevant to have access to age distribution, along with the seniority grades, to make a proper assessment of individuals' career progress and draw stronger conclusions from R&D data.

12. See Section 2.6.1 for more information on seniority grades.

Output tables produced to reflect these recommendations can be found in Annex 2.

Example of indicator on R&D personnel	
#	Indicators
1	Total and share of women researchers

corresponds to the number of the indicator in the SAGA Indicators Matrix (see Section 4).

5.5 Surveys of advanced qualification holders

Surveys on the experience and the career progress of advanced qualification recipients are an ideal platform to examine the impacts of individuals' attitudes, drivers, and barriers to specific programmes and career choices associated with the representation of women in STEM. Yet, these surveys are generally conducted periodically or on an *ad hoc* basis, and not by many countries. However, their potential in informing on a specific topic, for example the transition from education to work, should be considered of great value.

For examples of surveys of graduates, see:

- Survey of Earned Doctorates in the United States and Canada.
- National Graduates Survey in Canada.
- MORE surveys (Mobility and Career Paths of EU Researchers).

While surveys at the national level are useful in terms of providing governments with information on their highly educated population, they are limited when it comes to international comparison. The Careers of Doctorate Holders (CDH) project, a collective effort between the OECD, the UIS and Eurostat was launched in 2004 to overcome this lack of internationally comparable data on highly advanced diploma holders (Auriol et al., 2012).

For those using the CDH model, the SAGA project recommends the expansion of the population covered (ISCED level 8 Doctoral or equivalent) to include ISCED level 7 Master's or equivalent level.

For countries wishing to conduct a survey on the professional life of holders of higher education diplomas within their countries using the methodology suggested by the CDH, refer to the CDH website www.oecd.org/sti/cdh. Note that the D&B Survey should also be considered (see Section 5.1 and SAGA Working Paper 4).

5.6 Research funding agencies

Data from research funding agencies are a key source of information on access to research funding. Overviews of funding agencies' review procedures and awarded grants for research in STEM can reveal important disparities between men and women in the allocation of funding, an important factor in accessing higher levels of career achievement. Methodological guidelines for evaluating how research funding is awarded and to set in place mechanism to monitor the distribution to ensure equality between women and men is under development and preliminary information is available in Annex 3.

An internal assessment of the extent of gender mainstreaming in review and award procedures, and of the gender balance on committees can also inform on the existence and efficiency of internal policies aiming at providing equal access to funds. A variant of the STI Policy Survey, which will be developed as part of the SAGA project, will offer the methodology to conduct a review of institutional policies and data and will be available for public use in future version of this Toolkit.

Useful documentation:

- The U.S. Government Accoxuntability Office (U.S. GAO) produced *Women WIn STEM Research: Better Data and Information Sharing Could Improve Oversight of Federal Grant-making and Title IX Compliance*, (U.S. GAO, 2015).

5.7 Academies, professional associations and professional accreditation offices

S&E academies, professional associations and unions are important sources of information on the gender distribution of their members. A gap between men's and women's membership and diversity on committees in academies and associations can reflect an unequal access to professional opportunities and visibility. Simple analyses of members' characteristics can provide sufficient information to produce key indicators.

In 2006, the InterAcademy Council (IAC) published a report, *Women for Science: An Advisory Report*, which presented information and recommendations regarding the importance of women's full inclusion in science (InterAcademy Council, 2006). One of the recommendations highlighted in the report is the importance of collecting sex-disaggregated data from science academies and to report these data on a regular basis. In response, the InterAcademy Partnership (IAP) undertook the first comprehensive survey of IAP member academies, to which nearly 70 academies responded, and results were published in *Women for Science: Inclusion and Participation in Academics of Science* (ASSAFf, 2016).

Based on the IAC recommendation on the importance of the full inclusion of women in science, the IAP report makes recommendations for the promotion of the advancement of women in science, which is in line with the objectives of the SAGA project, both at the level of collecting sex-disaggregated data and in gender mainstreaming in activities. Therefore, a survey could be used with scientific unions, national associations and licensing bodies in order to extract valuable information on their members. A survey template will be made available to the public in a future version of the SAGA Toolkit and the following recommendations should be considered in the review of gender equality in academies, professional associations and professional accreditation offices.

1. **Review of membership information to include members' sex**

Without the distribution by sex of members, it is impossible to evaluate if there is a gender gap and its extent. This will complement information on member age and job title.

2. **Review of members of committees and board members by sex**

Similarly to sex-disaggregated information on members, the analysis of board members and committees of various kinds by sex contributes to the review of women's participation in top-level positions.

3. **Review of recipients of recognition, rewards and awards by sex**

The access to opportunities and recognitions in one's field is an important determinant of career achievements and of visibility of women in science. Thus, the distribution of recipients of actions of recognition and prizes should also be evaluated.

4. **Collect the fields of research of members**

The collection of detailed fields of research, using FORD[13] if applicable, should also be evaluated as it will give insights on the distribution across specific fields of science of members.

5. **Review of distribution of speakers and participants invited or selected for training, conferences, panels and workshops**

The distribution by sex of speakers and participants invited or selected for different events can be reviewed using list of participants, provided there is information on their sex.

13. See Section 2.6.1 for more details on the FORD.

Examples of indicators on academies, professional associations and professional accreditation offices

#	Indicators
33	Women as percentage of members of national science academies, by individual academy by broad discipline, expressed as mean and median shares respectively
34	Women as percentage of members of global science academies, by individual academy
35	Women as percentage of members serving on the governing body, by national academy
36	Total and share of women as speakers and participants invited or selected for training, conferences, panels and workshops (review of speakers-participants list)
37	Percentage of national academies with a women as president or chair by academy type
38	Existence of a gender policy or any document (strategy, policy, founding document, etc.) that explicitly mentions the need for increased participation by women in the academy's activities
39	Surveyed national academies that present a special award for women, and how often the award is presented
40	Percentage in agreement with statements about the participation of women in the national academy's activities
41	Existence of a committee that addresses gender/ diversity issues or anyone advising the academy on gender/diversity issues

corresponds to the number of the indicator in the SAGA Indicators Matrix (see Section 4).

Useful documentation:

- *Women for Science: Inclusion and Participation in Academics of Science from the Academy of Science of South Africa* (ASSAf) (ASSAF, 2016).
- International Astronomical Union for which the distribution of the members is displayed by sex and region.

5.8 Intellectual property information

Statistics on licensed patents can be used to measure women's productivity, an important determinant of merit and access to greater recognition in S&E careers. Intellectual property information can be found in national intellectual property databases and in international databases such as the World Intellectual Property Organisation (WIPO).

To generate indicators on gender equality amongst inventors and designers, information on listed inventors and designers must be accessible. This information may exist in the database of national intellectual property in which case a simple descriptive statistic is possible to evaluate the distribution of patent grants by sex. However, if the sex of inventors and designers is unavailable to conduct analyses incorporating the gender aspect, it should be integrated into application forms to enable future analyses by sex.

Alternatively, WIPO, a specialized agency of the United Nations, which promotes the protection of intellectual property around the world, has initiated the application of a sex matching to first name methodology by country of origin, on patent applications received under the Patent Cooperation Treaty to attribute the sex of inventors and designers. Thus, the use of algorithms for name matching to identify the sex of authors is now possible using the Harmonised Applicant Name (HAN) methodology (Eurostat and OECD).

The HAN methodology has been used on European Patent Office applications since 2005 and has proved successful in highlighting the differences in the productivity of women and men through patent grants. The HAN database will be available as an open source database (forthcoming WIPO working paper). Globally, the assignment of sex to names covers around 80% of first names and can be applied to inventors or designers but not to applicants, which are often firms rather than individuals. Since patent applications request both residence and nationality, the database can also be used for indicators on international mobility. For an introduction to the Eurostat/OECD HAN, refer to New Patents Databases with Harmonised Applicants' Names, which is available to researchers upon request.

Examples of indicators on intellectual property information

#	Indicators
42	Total and share of women as listed inventors
43	Total and share of patent applications with at least one woman as listed inventor
44	Total and share of patent applications with only women as listed inventors

corresponds to the number of the indicator in the SAGA Indicators Matrix (see Section 4).

Useful documentation:

- Global Entrepreneurship Monitor (GEM), *Key Indicators*.
- OECD & Eurostat, *New Patents Databases HAN*.

5.9 Bibliometrics

Bibliometrics, the statistical analysis of publications, can provide insightful views on women's participation and progression in S&E careers through their contribution to research and scientific output, collaboration with other scholars, and on research content. By combining information on authors by sex, either provided by the author or by name matching algorithms, it is possible to account for the productivity of researchers, which is also a proxy for gender disparities in research. A methodology on how to use bibliometrics to inform on the productivity of women versus men such as Elsevier's report *Gender in the Global Research Landscape* (Elsevier, 2017), will be available in future versions of this document.

Bibliometrics can also inform on the integration of the gender dimension in research content (GDRC), which considers the potential differences in research outcomes based on the biological characteristics, social and cultural attributes of both women and men in research content. In the European Commission's She Figures 2015, a new indicator for 'monitoring progress in the propensity to integrate the gender dimension in research content' is used: the proportion of a country's scientific publications integrating a gender dimension in their subject matter (European Commission, 2016, p. 97). This indicator does inform on the existence of a gender dimension in research content and, when measured periodically, will reveal if there is a growth in the integration of a gender dimension in research outputs by fields of science as it is observed over time (European Commission, 2016).

Based on *She Figures* 2015, the following methodology is recommended to identify the scientific publications which have a gender dimension in the content of their research. First, 'a keyword-based query covering both sex-related terms (biological characteristics of both women and men) and gender-related terms (social/cultural factors of both women and men)' is conducted (European Commission, 2016, p. 173). This request only enables one to know if a gender dimension is present in the content and does not give any additional information on how well it is integrated. Nevertheless, it gives a measure on the integration of the GDRC.

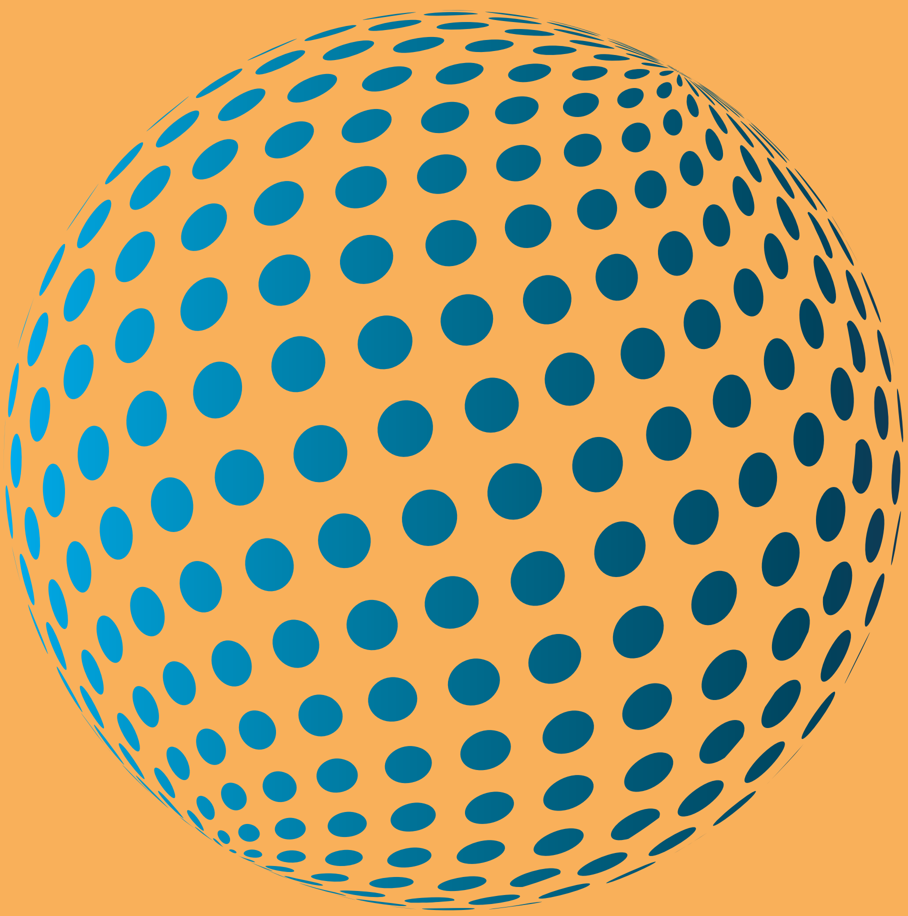
Example of indicator on bibliometrics

#	Indicators
45	Proportion of a country's scientific publications integrating a gender dimension in their subject matter by field

corresponds to the number of the indicator in the SAGA Indicators Matrix (see Section 4).

Useful documentation:

- Elsevier, 2017, *Gender in the Global Research Landscape*, Amsterdam, Elsevier.
- European Commission, 2016. *She Figures 2015*. Gender in Research and Innovation. Brussels: European Commission.
- *Elsevier, 2015, Mapping Gender in the German Research Arena*, Elsevier.
- World Bank & Elsevier, 2014, *A Decade of Development in Sub-Saharan African Science, Technology, Engineering, and Mathematics (STEM) Research*, Washington, DC, World Bank Group.



Annexes

ANNEX 1 - Education data sources

Students

Tertiary education

To help report the information on education to assess gender equality and as recommended in Section 5.2, Table 10 can be used. Similarly, this table can be used for first-time new entrants to evaluate the number of students newly entering programmes after policies are adopted.

To measure the progression of students from their enrolment to the successful completion of their programme, information on the number of women and men enrolled at the beginning of an education programme and the number of women and men who graduate from it is required. This information should be accessible from national data on education or institutional registration information and UIS collects it at the global scale through the UNESCO Survey of Formal Education. The output table format recommended in Table 10, inspired from these surveys, should be used to facilitate the reporting of information on education.

Table 10. Number of students by level of education, detailed field and sex

Fields of study				ISCED level of education				
Broad field		Narrow field		5	6	7	8	Total
00	General programmes and qualifications	001	Basic programmes and qualifications					
		002	Literacy and numeracy					
		003	Personal skills and development					
01	Education	011	Education					
02	Arts and humanities	021	Arts					
		022	Humanities (except languages)					
		023	Languages					
03	Social sciences, journalism and information	031	Social and behavioural sciences					
		032	Journalism and information					
04	Business, administration and law	041	Business and administration					
		042	Law					
05	Natural sciences, mathematics and statistics	051	Biological and related sciences					
		052	Environment					
		053	Physical sciences					
		054	Mathematics and statistics					
06	Information and communication technologies	061	Information and Communication Technologies (ICTs)					
07	Engineering, manufacturing and construction	071	Engineering and engineering trades					
		072	Manufacturing and processing					
		073	Architecture and construction					
08	Agriculture, forestry, fisheries and veterinary	081	Agriculture					
		082	Forestry					
		083	Fisheries					
		084	Veterinary					
09	Health and welfare	091	Health					
		092	Wealth					
10	Services	101	Personal services					
		102	Hygiene and occupational health services					
		103	Security services					
		104	Transport services					
Not known or specify								
Total: All fields of education								

Useful documentation:

For more methodological information on how to conduct a survey of formal education, refer to:

- UNESCO-UIS, 2016. *Instruction Manual: Survey of Formal Education,* Montreal, Canada: UNESCO-UIS.

ANNEX 2 - R&D surveys

Considering the recommendations on data collection for R&D surveys in Section 5.4, output tables have been elaborated to facilitate the reporting of the information collected. Tables 11 to 13 correspond to the recommendations from Section 5.4. For more details on the definition of the R&D personnel (researchers and technicians and equivalent staff) included as STEM population by SAGA, see Section 2.6.1.

Recommendations

1. Collect information on researchers and technicians by sex and at the first (broad) and second (narrow) level of for the fields of R&D.

Table 11. Headcount of all R&D personnel and broad fields of R&D

RESEARCHERS			
Field of R&D (Broad)	M	F	Total
Natural sciences			
Engineering and technology			
Medical and health sciences			
Agricultural and veterinary sciences			
Social sciences			
Humanities and the arts			
Not specified elsewhere			
TOTAL RESEARCHERS			

TECHNICIANS AND EQUIVALENT STAFF			
Field of R&D (Broad)	M	F	Total
Natural sciences			
Engineering and technology			
Medical and health sciences			
Agricultural and veterinary sciences			
Social sciences			
Humanities and the arts			
Not specified elsewhere			
TOTAL TECHNICIANS AND EQUIVALENT STAFF			

Table 12. Headcount of R&D personnel (researchers) and narrow fields of R&D

NATURAL SCIENCES	M	F	Total
Mathematics			
Computer and information sciences			
Physical sciences			
Chemical sciences			
Earth and related environmental sciences			
Biological sciences			
Other natural sciences			
Total researchers and equivalent staff in natural sciences			

ENGINEERING AND TECHNOLOGY	M	F	Total
Civil engineering			
Electrical engineering, electronic engineering, information engineering			
Mechanical engineering			
Chemical engineering			
Materials engineering			
Medical engineering			
Environmental engineering			
Environmental biotechnology			
Industrial biotechnology			
Nano-technology			
Other engineering and technologies			
Total researchers and equivalent staff in engineering and technology			
MEDICAL AND HEALTH SCIENCES	M	F	Total
Basic medicine			
Clinical medicine			
Health sciences			
Medical biotechnology			
Other medical science			
Total researchers and equivalent staff in medical and health sciences			
AGRICULTURAL AND VETERINARY SCIENCES	M	F	Total
Agriculture, forestry, and fisheries			
Animal and dairy science			
Veterinary science			
Agricultural biotechnology			
Other agricultural sciences			
Total researchers and equivalent staff in agricultural and veterinary sciences			
SOCIAL SCIENCES	M	F	Total
Psychology and cognitive sciences			
Economics and business			
Education			
Sociology			
Law			
Political science			
Social and economic geography			
Media and communications			
Other social sciences			
Total researchers and equivalent staff in social sciences			
HUMANITIES AND THE ARTS	M	F	Total
History and archaeology			
Languages and literature			
Philosophy, ethics and religion			
Arts (arts, history of arts, performing arts, music)			
Other humanities			
Total researchers and equivalent staff in humanities and the arts			
TOTAL RESEARCHERS			

Table 13. Headcount of R&D personnel (technicians and equivalent staff) and narrow fields of R&D

NATURAL SCIENCES	M	F	Total
Mathematics			
Computer and information sciences			
Physical sciences			
Chemical sciences			
Earth and related environmental sciences			
Biological sciences			
Other natural sciences			
Total technicians and equivalent staff in natural sciences			
ENGINEERING AND TECHNOLOGY	M	F	Total
Civil engineering			
Electrical engineering, electronic engineering, information engineering			
Mechanical engineering			
Chemical engineering			
Materials engineering			
Medical engineering			
Environmental engineering			
Environmental biotechnology			
Industrial biotechnology			
Nano-technology			
Other engineering and technologies			
Total technicians and equivalent staff in engineering and technology			
MEDICAL AND HEALTH SCIENCES	M	F	Total
Basic medicine			
Clinical medicine			
Health sciences			
Medical biotechnology			
Other medical science			
Total technicians and equivalent staff in medical and health sciences			
AGRICULTURAL AND VETERINARY SCIENCES	M	F	Total
Agriculture, forestry, and fisheries			
Animal and dairy science			
Veterinary science			
Agricultural biotechnology			
Other agricultural sciences			
Total technicians and equivalent staff in agricultural and veterinary sciences			
SOCIAL SCIENCES	M	F	Total
Psychology and cognitive sciences			
Economics and business			
Education			
Sociology			
Law			
Political science			
Social and economic geography			
Media and communications			
Other social sciences			

Total technicians and equivalent staff in social sciences			
HUMANITIES AND THE ARTS	**M**	**F**	**Total**
History and archaeology			
Languages and literature			
Philosophy, ethics and religion			
Arts (arts, history of arts, performing arts, music)			
Other humanities			
Total technicians in humanities and the arts			
TOTAL TECHNICIANS AND EQUIVALENT STAFF			

2. Collect information on researchers by sex and seniority grades.

Table 14 and Table 15 show how the data should be reported for researchers, by sex and seniority grade, and age, especially for the government and higher education sectors, as recommended by the FM. The seniority grades are presented in Section 2.6.1. and a mapping between the national levels of seniority to the FM should be developed to ensure comparability across nations and regions. Lastly, the information can be reported either as headcount or for full-time equivalent – see Section 5.4 for more information on headcount and FTE.

Table 14. Researchers by sector of employment, sex and seniority grade

			Sector		
			Government	Higher education	Total
Headcount*	Male	Grade A			
		Grade B			
		Grade C			
		Grade D			
		Total researchers			
	Female	Grade A			
		Grade B			
		Grade C			
		Grade D			
		Total researchers			
	Total	Grade A			
		Grade B			
		Grade C			
		Grade D			
		Total researchers			

* The information can also be collected for FTE, in addition to headcount.

3. Collect information on researchers by sex and age

Table 15. Researchers by sector of employment, sex and age

			Sector		
			Government	Higher education	Total
Headcount*	Male	Under 25			
		25-34			
		35-44			
		45-54			
		55-64			
		65 and over			
		Total researchers			
	Female	Under 25			
		25-34			
		35-44			
		45-54			
		55-64			
		65 and over			
		Total researchers			
	Total	Under 25			
		25-34			
		35-44			
		45-54			
		55-64			
		65 and over			
		Total researchers			

* The information can also be collected for FTE, in addition to headcount.

Useful documentation:

For the complete guidelines and model questionnaires on conducting R&D surveys, refer to:

- UNESCO-UIS, 2014a, *Guide for Conducting an R&D Survey: For countries starting to measure research and experimental development,* Montreal, UNESCO-UIS.
- OECD, 2015b, *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development*, Paris, OECD Publishing.

ANNEX 3 - Research funding agencies

The following main methodological recommendations to review the information collected from research agencies on grant applications and funding recipients are provided as guidelines and will be further developed in future versions of this document.

1. Selecting research funding agencies

The review of research funding agencies can be done systematically for all agencies for a given territory. It can also be conducted on a selected number of agencies, which can be chosen based on the total amount of funding allocated to research in STEM fields for a given period of time, such as a fiscal year. For example, in the United States, the GAO report *Women In STEM Research: Better Data and Information Sharing Could Improve Oversight of Federal Grant-making and Title IX Compliance* (U.S. GAO, 2015), only the six federal agencies responsible for funding 90% of STEM research were selected for inclusion.

The criteria to include funding agencies in the U.S. GAO review were:

1. Agencies fund research in core STEM fields only (computer and information technology, engineering, mathematics, physical and life sciences, and statistics);
2. Funding is available for basic and applied research at the graduate, post-graduate, and principal investigator or full professor level; and
3. Funds are distributed through external grants or cooperative agreements.

2. Inventory of data available on individuals and grants by agency, system in place for collecting and analysing these data

The selection of agencies should be followed by an assessment of the information system in place for collecting information on the individuals who apply for funding. The information is likely to vary across agencies, both the information collected but also its format. A review of the data available can reveal gaps in the information available and can assist in the improvement of data systems.

It is essential to collect the sex of applicants to be able to compare and evaluate the gender gap between men and women within research funding distribution. In addition, the following information for all applicants should also be collected:

- Age or year of birth
- Race or ethnicity
- Highest degree received
- Year highest degree awarded
- Organizational affiliation
- Institution type (college, research university or institution, academia etc.)
- Applicants' field(s) of research
- Information on co-investigator(s)
- Amount requested by applicant
- Amount awarded to applicant
- Principal investigator(s) full name(s) or identifier(s) (for internal purposes only)
- Fiscal year of award
- Duration of award funding

Additional variables of interest:

- Award status (approved, declined, invited to resubmit)
- Award type
- Type of proposal (initial, modification, reapplication)
- Team composition by sex

ANNEX 4 - Academies, professional associations and professional accreditation offices

From the methodological guidelines of the IAP report, it is recommended that academies and professional associations collect the following information about members in as much detail as possible:

- Sex
- Highest level of education
- Discipline/field (more than one possible)
- University granting highest diploma
- Year of highest degree
- University of current enrolment
- Field of research
- Nationality
- Current position
- Type of employer/institution
- Career status (student through retirement)
- Areas of speciality
- Regional focus
- Field of study
- Other association memberships

A survey similar to IAP's is under development by SAGA and the methodology and other relevant material will be made available in a forthcoming version of this Toolkit.

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Natural Sciences Sector

United Nations Educational, Scientific and Cultural Organization

UNESCO INSTITUTE FOR STATISTICS

MEASURING GENDER EQUALITY IN SCIENCE AND ENGINEERING: THE SAGA TOOLKIT

Working Paper 2

The under-representation of women in STEM translates into the loss of a critical mass of talent, thoughts and ideas, which hinders countries from reaching their maximum development potential. In order to monitor and evaluate gender equality and to integrate gender aspects in science, technology and innovation (STI) policies, the UNESCO *Measuring Gender Equality in Science and Engineering: the SAGA Toolkit* looks into and links two central aspects for addressing gender equality in STEM: policies, and indicators as evidence for policies in STI. It sets out a conceptual and methodological framework and provides a series of tools to integrate, monitor and evaluate gender equality in STEM.

The *SAGA Toolkit* is intended to assist national governments, education and research institutions, national science foundations, development agencies, evaluators, and international institutions in the design of gender-sensitive and evidence-based policies to evaluate the gender-related STI policies coverage and strengthen national gender policy agendas in STI. In doing so, the SAGA Toolkit establishes a new basis for evidence-based policy-making in STI by setting standard definitions and classifications to address the gender gap in STEM more effectively.

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