



S.O.S. Booklet for Global Young Scholars

Facing the Scientific and Ethical Challenges of the Modern Age

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Introduction

Workshops are ideal getaways for scientists: they carry the premise of innovation through constant, uninterrupted interaction. In a framework of a workshop, the networks are fairly quickly established, nodes are fast identified and bonds secured. The “GYA/IAP Young Researchers Leadership Workshop” was one such event, organized under the auspices of the World Science Forum 2019. This workshop is considered as rather unique because it gathered forty promising scholars (in the early stages of their academic careers), from four corners of the world, and five different continents. The scholars were nominated by their national academies (based on their outstanding portfolios) and selected by the co-hosting organizations (the InterAcademy Partnership, Global Young Academy and the Hungarian Academy of Sciences). Soon, the diversity and versatility created a hub of creative thinking, and facilitated the outputs. By the end of the days, encouraged by the facilitation team from Knowinnovation/Inclusive Innovation, participants engaged in so many ways, that results inevitably followed. So, what started as a daring social experiment, unfolded beautifully as a scientific experiment of a sort. Indeed, for the concluding exercise people were performing some simple scientific tasks: identifying the most urgent scientific and ethical challenges of the modern age (via the method of brainstorming), performing real-life, macro-scale analysis (by clustering separate challenges into similar groups), and charting models to find the possible

solutions (organized in teams). Here, we summarize the main outcomes of our final exercise. By the time we arrived to the solutions, we have already grown as teammates.

The following document is also an attempt to join forces, and reinforce the proactive voices coming from our fellow peers, from all parts of the world. We believe that a world so vehemently perturbed by vicious circles of disinformation, would greatly benefit from any attempt to perpetuate virtuous circles of valuable information. Therefore, we took it upon ourselves to set a positive example and support the strong unison voice by the global young leaders which resounded with clear and resonant messages on many occasions at the World Science Forum 2019. The Declaration on the Guiding Principles of Young Academies¹ in particular, is a document that proved to be instrumental upon shaping of our material. It was launched in our presence, and with us as witnesses to the power of joint efforts and shared core values. It inspired many of our thoughts (about the positive impact of science on the society, the diversity and inclusivity, as well as the responsiveness and responsibility of young scientists). However, we still keep a line of distinction in our material by emphasizing the role of individuals (instead of academies) and emerging young leaders in particular (as predecessors to the future established leaders). We specifically focus on the need for personal improvement in parallel to the desire for personal advancement. Here, we would also like to acknowledge the Code of Conduct², issued by a group of young scientists at the World Economic Forum 2018. This document provided a very good starting base for our booklet, and inspired our approach. We considered their written recommendations and tried to place them in a causal model, first by identifying the problem, then pointing to its related challenges, only to conclude by a short summary of available solutions. We believe that both documents are complementary, as they both help to face current obstacles as challenges, and to focus on the solutions rather than the problems.

CONTENTS

We hope that the material at hand, will be strong testament to the power of youth, action, education and encouragement, inspiring many forthcoming generations of scientists.

¹Oni, T., Toldi, Gergely., Jayasundara, D., Egbetokun, A., Ahmed, N., Rios, C. (2019). Declaration on the Guiding Principles of Young Academies. *Berlin: Global Young Academy*. Retrieved from: <https://globalyoungacademy.net/wp-content/uploads/2019/11/Declaration-YAs-2019.pdf>

²Young Scientists. (2018). Code of Conduct. Geneva: World Economic Forum. Retrieved from: http://www3.weforum.org/docs/WEF_Code_of_Ethics.pdf

Science and Society: How to bridge the gap between science and society?

Science of today is accessible to virtually any citizen (mostly via internet) and it is usually practiced by the educated scholars. This was not the case until very recently. Indeed, throughout all human history, the knowledge landscape was populated by the elites. The learned societies consisted of the wisest and the wealthiest, or the best and the richest, the chosen few who were granted access to science. In the last decades however, the positions are gradually changing and tables are slowly turning toward a better and less exclusive science. Indeed, modern science can be easily used, but it also can be abused. The global citizenship, the increasingly interconnected societies and the advanced technologies can instantly transform the perks of modern science into its perils and its potentials into its pitfalls. The result is often a paradox: a society that is heavily wired and equipped with instant access to every citizen and every sci-

entific fact, suddenly becomes distanced from both science and its citizens. The gap between society and science becomes so evident, that the need for action is urgently required.

The problem A void is quickly widening between scientists and citizens of today. The abyss becomes filled with unfiltered noises and resounding echoes from the ideological echo chambers (via social networks), the propaganda and disinformation machineries (via modern media), moral outrage and hate speeches from groups and individuals (via digital platforms)³. In the era of the modern living, one saying strikes with a particular meaning: a lie can travel around the world and back, while the truth is still lacing up its boots. In fact, nowadays the proverb is so amplified that it becomes alarming, and intensified enough to even become distressing. So much so, that the quest for truth quickly morphs into a race with time.

The challenges The time-pressing circumstances orient our quest for solutions towards deconstruction of the existing relationships: between scientists and citizens on the one hand, or between scientific institutions and governmental bodies on the other. Both relationships on both sides are often burdened with stereotypical and prejudiced regards, judgements or even accusations. For instance, scientists are often viewed as professionals who are distant, disinterested and disconnected from the society, due to the lack of an immediate visibility of their work results. Hence, they are increasingly exposed to public scrutiny and (often unsupported) criticism by ill-intended or less-competent individuals/groups. Their findings are frequently denied, exaggerated or misinterpreted by various sources and for various reasons. Also, scientific institutions are often included in conspiratorial narratives or plots, and described as conduits of some/one's secret agenda or propaganda. On the other hand,

³Marwick, A., Lewis, R. (2017). Media Manipulation and Disinformation Online. *New York: Data & Society Research Institute*. Retrieved from: https://datasociety.net/pubs/oh/DataAndSociety_MediaManipulationAndDisinformationOnline.pdf

scientists and institutions perceive the attempts for bottom-up approach and grassroots movements as inefficient. As a result, they consequently invest insufficient efforts to engage with the public. This produces a reduced trust in science and decreased perception of trustworthiness of its gatekeepers (i.e., the researchers) or enablers (i.e., the scientific institutions). The final outcome is an overall drop in the critical thinking and media literacy of citizens, and the rise of populism around the world, as the main challenges of the modern age.

The solutions The relief in the tension and relaxation of the strenuous relationship between scientists and citizens, can only be achieved through joint efforts on both sides. The scientists can strengthen ties with citizens via the mediators (science journalists) by taking to the available platforms and media outlets. Also, they could act as science communicators themselves, firstly by attending adequate training courses that will empower them to effectively voice their outcomes to a larger audience⁴. The science communication strategies could include: issuing press releases and providing accurate, precise and fact-checked information in a written format (on science blogs, websites and portals), or engage in public debates and invited talks in front of wider public. Effective science communication would reap the best results if it is especially focused towards policy makers and governmental representatives, and considered upon creating strategies, or voting public measures and policies. Young global scholars are also important as they can easily bridge the gap between the nations (blending mobility with multiculturalism) and generations (blending experience with enthusiasm), thus serving as cultural and societal ambassadors. On the other hand, citizens could strengthen ties with scientists by becoming citizen scientists themselves. Namely, they could inform and improve the scientific conduct by asking relevant questions or

providing empirical insights, thus becoming cooperators (to scientists) and indirect consultants (in the research process). In order to do so, they would be acquainted/skilled in the critical thinking and problem solving strategies, because they will have direct access to the sources of science (by interacting with scientists on public seminars, open days, workshops). So, an integrated approach by the system (evident in the introduction of critical thinking very early in the educational process), by scientists and citizens together, will improve the cultural understanding, the collective well-being, and democracy in today's societies.

⁴World Science Forum. (2019). Declaration of the 9th World Science Forum. *Budapest: Hungarian Academy of Sciences.* Retrieved from: https://worldscienceforum.org/data/cikkek/declaration/WSFdeclaration2019_print.pdf

Science and the Self: How to turn our weaknesses into strengths?

The problem Scientists are often regarded as professionals with enhanced freedom and autonomy, increased mobility and adaptability. As such, they are expected to easily overcome great distances, language barriers or organizational difficulties and to delve directly into science. As a result, they are often neglected as individuals with personal needs and fears, desires and challenges, striving and hesitations. So, enabling a supportive work environment where scientists can flourish as individuals and professionals, while their soft skills and work capacities can reach the peak of their potential, bears an utmost importance. Hence, we need to address the topic of continuous self-analysis and self-improvement, but also issues like burnout or self-exploitation and work-life balance as major challenges among young scientists.

The challenges Nowadays, scientists are often invited, addressed, presented, or acknowledged simply as experts. The

word ‘expert’ itself is rather controversial and contested with opposing meanings. One is pejorative (when the term is trivialized, banalized and emptied from its content) while the other is authoritative (when it seems imposing and self-evident). Either way, scientists as experts are often perceived as professionals with inhuman properties (endowed with either business-like or god-like characteristics, the latter even referred as ‘scelebs’), ready to jump at the opportunity and accept any given challenge. The situation might be worsened by the very demanding work requirements for highly qualified researchers with outstanding competences, and a strong competitive environment. All this could instigate undesirable behavior (more selfish than altruistic), and push ambitious scientists into extremes of self-exploitation, self-exhaustion and burnout syndrome.

The solutions The first step would consist in a broad analysis of self, and the labels which predominate the scientific discourse. As a result, the real issues would be called by their real names, and the challenges will be properly addressed. Our thoughts precede words, and our words proceed to shape actions, so the quest for self-improvement should always be mindful of how our thoughts are materialized, and how our actions realized. We should start from the very beginning and replace the phrase ‘self-development’ (which can be regarded as mechanistic) with ‘personal investment’ as an expression that is more humane and more suitable altogether. According to the personal investment theory⁵, the driving force (i.e., motivation) behind each professional achievement depends on the following factors: one’s perception of oneself (i.e., dispositional traits like the sense of competence, self-reliance, goal-directedness); perceived possibilities in one’s surroundings (i.e., situational factors like the choices and alternatives available in the situation at hand) and the personal incentives (i.e., the professional advancement in status and affiliation, as well as mastery of skills). So, the phrase ‘personal investment’ mphasizes the very process

rather than the result, the means instead of the end. This could lead to a shift from a goal-directed behavior (implying machiavellian approach based on ambition) to a learning-oriented behavior (emphasizing the main outcome of each research undertaking). Speaking of which, the ‘problem-solving strategies’ (focusing on the problem and implying a negative regard) could also be replaced with ‘challenge-seeking activities’ (emphasizing the proactive and overall positive approach). Also, the idiom ‘soft-skills’ could be equally considered as the term ‘analytical skills’ or ‘reflective skills’ since all are deemed relevant for researchers (to bind empathy with rationality). In fact, according to the Immediate Past Co-Chair of the Global Young Academy (2019/2020), the term ‘soft skills’ should even be eradicated and replaced with the expression ‘critical skills’ because if the science requires “to step-up, to lead the way in achieving a more inclusive and peaceful society, these are indeed the critical skills that are required of the scientists”⁶. Once the challenges are recognized and addressed, the second step would be to accept them. On the educational level this would imply an update of the curricula to include courses for personal improvement and professional advancement, as well as update of professional relations to include frequent consultations, team-building activities with peers, counseling sessions with superiors, and scientific communication with citizens for dissemination of results. What could follow next, is unfurling of a chain of reactions, both visible on the individual and the societal level, that could inevitably improve life of the scientists and the science of the modern day.

⁵Maehr, M. L., Braskamp, L. A. (1986). *The Motivation Factor: A theory of Personal Investment*. Lexington Books: DC Heath and Com.

⁶Address speech by Dr. Tollulah Oni. (2019). Thematic Session on Science for Peace: Success and Future Responsibilities. *Budapest: World Science Forum*. <https://mta.videotorium.hu/en/recordings/35426/thematic-sessions-i-a-science-for-peace-successes-and-future-responsibilities>

Ethics in Science: How to conduct ethical and responsible research?

The problem Scientific research tends to be formal and objective, while ethical considerations may be subjective. Science relies on facts, while ethics relies on reaching mutual understanding and consensus of shared opinions. Specifically, ethics consists of recommendations for groups (ranging from professionals to nations) referring to: high quality practices, legally sound procedures and outcomes for the greater good of the citizens. Scientists are bound to follow ethical rules by the nature of their call (serving as advocates of the objective truth), and often by the nature of the job (especially when it involves human or animal subjects). However, outside the mentioned confines, scientists are rarely instructed on what they should specifically do, and what they should not. This enables the freedom and autonomy of the scientist, as well as trustworthy relations between researchers, which are the main prerequisites of con-

ducting science. However, here we specify some additional recommendations and outline possible solutions, that would help global young scientists in conducting ethical research.

The challenges The world of science is burdened with ethical dilemmas and riddled with a myriad of possible solutions. One of the many questions for instance, is whether we are allowed to interfere in our future offspring's genome? Can we 'play' with embryo cells? Can we modify stem cells? Can we create human-animal hybrids? How about producing genetically modified plants or products? Can we allow robots to "live", make deals, or even kill? There are many controversies which need to be addressed by science ethics. But who can decide on the recommendations, limitations, and cut-off values? Who can voice, impose or even enforce them? More importantly, are scientists obliged (by law or other means) to accept these values or not? The vast world of ethical challenges is approached in differing ways by different scientists (depending on their upbringing, training, socio-cultural surrounding, and their understanding of the issue at hand). Typically, some succumb to the utilitarian approach and consider the outcomes through the lens of the greater good for many (the so-called 'primum optime curare' principle in medical ethics). Others, are acquiring the deontological approach and always considering the beneficial outcome in absolute terms (i.e., 'primum nil nocere' principle in medical ethics)⁷. Both groups of scientists are dealing with science as an open platform for improving society and humanity as a whole.

The solutions These controversial aspects and issues could be solved through an integrated framework. Both governmental institutions (e.g. ministries of education and science) and academic institutions (i.e., universities, research institutes, or science publishing outlets) should assume proactive roles for eth-

⁷World Medical Association. (2013). Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. 64th WMA Assembly, Fortaleza, Brazil. Retrieved from <https://www.wma.net/wp-content/uploads/2016/11/DoH-Oct2013-JAMA.pdf>

ical conduct of science. Associations of academies⁸ and international scientific organizations are advised to come forward with recommendations, codes of conduct, declarations or manifestos for conducting ethical research practice. Within science organizations, SWOT analysis should be performed to identify the internal strengths and weaknesses, while plenary surveys and case studies should be conducted to address the community issues. The role of the funding agencies should be equally discussed and funding process carefully monitored (as described in the section on “Ethical funding in Science”). Different sanctions or penalties can be considered for the misusers or abusers of science, as security measures. On the other hand, certain recognitions (like badges of honor, material awards, special mentions or other benefits) can be considered for prominent and exemplary individuals, who set a positive example and stimulate the others toward achievement of the same goal. With regards to the wider society, promotive materials (i.e., booklets, leaflets or flyers) should be developed, published and disseminated. Public fora should be held frequently to discuss and resolve ethical issues, raise public interest and awareness, as well as mark societal progress in parallel with the advances in science.

⁸All European Academies (ALLEA). (2017). The European Code of Conduct for Research Integrity. *Berlin: Brandenburg Academy of Sciences and Humanities*. Retrieved from https://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf

Funding in Science: How to ensure fair allocation of funds to promising researchers?

Scientific research is a rather complex process consisting of fairly simple procedures. The scientific pursuit is usually based on the logical, systematic and sequential order of steps: search for new information about a particular subject, finding the causes, coming up with the solutions, and proposing applications of the newly established knowledge. This process costs money on both the operative level (i.e., enabling human/material resources for execution of tasks) and the experimental level (i.e., conducting basic/applied science). So, how do researchers manage the available financial resources, in order to do good-quality, responsible work? How can researchers get money from different sources? And moreover, how can this process be more ethical, in order to balance and equalize opportunities for both junior and senior researchers?

The problem Researchers need a total or partial covering of their basic scientific activities as well as management of the additional costs. These include: a) operative costs (i.e., fees for equipment, office and laboratory rental/use, materials, suppliers, consumables, computing and technical data infrastructure rental/use fee), b) personal salaries (i.e., regular payments or wages of principal investigators, co-investigators, researchers, student/s, technicians and research staff/s), as well as c) other direct costs (i.e., travel related to sampling of material/s or data analysis required for research activities, information technology helpdesk services, publication costs, workshops, conferences, facilities, intellectual property registration, etc).

The challenges Science funding processes have shifted from support based on public and private initiatives (as well as donations by philanthropists), to support dependent on personal motivation, decisiveness and inventiveness of research individuals or teams. Due to limited grant policies and interest for-profit funding, it is getting harder to find open funding from public and/or private grants. Generally, funding opportunities are not discriminative across scientific disciplines especially between fundamental and applied research (even though there are certain differences between those domains with regards to the public outreach, immediate/postponed impact, or interconnection with the rest of the knowledge, as well as with the industry and other economical players). On the other hand, the available material sources remain disproportionate and depend strongly on the applicant's age and experience (especially favoring senior or experienced applicants who enjoy incommensurate advantages, in comparison with junior and/or emerging scientists). Another problem of such funding systems is that they often fail to conserve and enhance diversity within the scientific community (e.g. by providing specific funding for scientists taking parental leave, or having other special circumstances). Please refer to the section on "Inclusivity in Science" for more elaborate considera-

tions on the topic. This happens especially when the evaluation is mostly based on scientometric data, while the originality of the scientific idea is less important. Similarly, funding of basic science questions should not be overlooked and under-financed when compared with industry-driven science. Therefore, it is of utmost importance to consider different kinds of grants in order to separately evaluate basic and fundamental research, as well as senior and junior researchers.

The solutions Firstly, the available funds should be proportional to the GDP in each country, and they should come from different sources, such as public, private, personal and cooperative (crowdfunding) agencies. As regards the latter, various funding opportunities (which are not conventional in a strict sense) exist nowadays: different agencies can offer grants, fellowships, and full coverage for scientific research. So, offering matching strategies (i.e., proposals based on total centralization or decentralization of scientific funding) can be successful in certain cases. In addition, professional organization, as well as transparent evaluation systems (with possibilities for bilateral feedback) are the key assets of a good funding agency, which has to manage both public and private funds. Specific grant proposals and equitable evaluation may help young scientists to become independent and may also help the (re)integration of scientists with special life circumstances (e.g., returning to work after a parental leave). Agencies should also provide credit for childcare both for application (e.g., for the age limit) and also during evaluation of one's scientific output. Finally, internal institutional organization and high quality-control practices must be established, in order to: evaluate scientific merits of applicants; frequently monitor their science-related activities; and check the quality of the outcomes that have been financed. The interconnections and inter-relatedness between science and industry, with information transfer between fundamental science and the industrial research should be enhanced in both direc-

tions, as it would ultimately work for the profit of not only scientists or businessmen, but the society as a whole.

Inclusivity in Science: How to reduce existing inequalities in science?

The world of academia resides upon constant imbalance between genders, races, ethnicities, classes. Although the number of female scientists has been increasing in the last few decades, it continues to be disproportionately lower than the number of male scientists in most countries, especially with regards to science, technology, engineering and mathematics (STEM)^{9,10}. The imbalance is present not only between different genders, but also in people with different origins or backgrounds, persons with disabilities, and other underrepresented social groups. Inequalities often start to form very early on by limited access to primary education, and with time they only grow bigger, stronger and louder. As a result, the inequalities at the high-

est scientific career stages (postdoctoral researchers, principal investigators, professors) become evident and challenging, and thus require urgent action.

The problem In its essence, the scientific research presents a creative process requiring divergent thinking and always considering different approaches and perspectives. The long-standing research in the fields of sociology, economics and organizational psychology have consistently confirmed that having a more diverse scientific community would result in more innovative scientific solutions¹¹. Apart from higher-quality results and enhanced creativity in the research process, increased inclusivity in science would also ensure a more just, respectful and open working environment, where all human potentials would have a chance to flourish. Thus, the society, the institutions and the individuals would benefit from a more inclusive scientific community.

The challenges Inequalities experienced by individuals from vulnerable groups spread in concentric circles: starting with the most basic unit (i.e. family) and spreading up to the widest portions (i.e. society). Obstacles that are present from the very start, are broadly shared values and stereotypes, limited access to education and other resources, poor educational support at home and at school. With such disadvantaged position, the task of overcoming obstacles and regarding them as challenges requires more than a strong will. It requires organized and coordinated support from different actors. Even if a person manages to overcome all these obstacles and pursues an academic career, it is likely that s/he would experience unequal

⁹Academy of Science of South Africa. (2015). Women for Science:: Inclusion and Participation in Academies of Science. *Pretoria: ASSA*. Retrieved from https://www.assaf.org.za/files/ASSAF%20news/ASSAF_IAP%20Report%20Final.pdf

¹⁰European Commission. (2003). Enwise Report, Waste of Talents: Turning Private Issues into a Public issue. *Brussels: European Commission*. Retrieved from https://ec.europa.eu/research/swafs/pdf/pub_gender_equality/enwise-report_en.pdf

¹¹European Institute for Managing Diversity. Diversity and innovation: A business opportunity for all. *European Community Program for Employment and Social Solidarity (2007-2013)*. Retrieved from <http://www.iegd.org/pdf/Task%203%20-%20Innovation.pdf>

employment opportunities and pay rate, difficulties in managing work-life balance, lack of mentorship and limited access to leadership training programs and higher positions, which may all lead to higher dropout rates and shorter career paths.

The solutions The obstacles which encircle like high walls the affected groups and individuals, require coordinated action which would spread like circles of water to the furthest reaches in the society. At the level of family and local community, access to proven information, material and psychosocial support, as well as successful role models should be ensured.

At the level of educational system, policies that support unbiased and fair quality education, scholarships based on families' incomes and students' needs, grants for school and communities in disadvantageous regions and training for the school staff are required. Regular educational programs promoting critical thinking, as well as specialized extracurricular activities accessible to all children are needed.

At the level of the work units, diversity and inclusion issues can be diagnosed using research methods such as climate surveys or interviews, conducted by sensitized and well-trained professionals. Results can inform the policymakers based on transparent and efficient procedures to prevent biases and irregularities in the hiring and professional development process, to prevent pay gaps, abuse of power and exclusion from the decision-making process. Namely, young female scientists and other individuals from vulnerable groups (but also anyone else) can feel protected and respected in their work environment when they are regarded in equal terms with others, but also when they are treated in empathic and flexible manner (especially with regards to the working shifts, hours and places, parental leave programs, and supporting programs to facilitate reintegration after career interruptions). Workplaces that are

open for networking and peer support groups, dedicated mentorship and collective leadership are of utmost importance.

Finally, at the societal level awareness-raising campaigns that would alleviate stereotypes and prejudices among people are needed. In realization of educational and psychosocial support programs at schools, several actors should play an important role: universities and local communities, science communicators and media, as well as representatives of NGO's and international organizations. Policies which facilitate the work of minorities within the wider scientific environment (e.g. by inclusion of participants with diverse backgrounds in conferences/workshops, or by unbiased awarding of prizes of selection committees) are strongly recommended and (judging by the workshop experience of the contributing authors), proven to effectively work.

Leadership in Science: How to cultivate a young collective leader?

Scientific approach implies deductive reasoning with invention of sound hypotheses or theories, supported by solid data, reliable methods and standard practices. It usually involves careful observation of phenomena of interest, sometimes followed by repetitions with experiments. The scientific practice as invented and conducted by humans, is a creative and often unpredictable task. It's course is dynamic (ever-changing) and plastic (easily-adaptive). This process has become increasingly facilitated with the fast technological progress, so efficient management of all available resources (human, informational, technological, material) is much needed in order to optimize the scientific outcome. Therefore, a model leadership, relying on respectful relations and team cooperation, will maximize the joint efforts towards the achievement of a shared goal. The collective leadership represents one such 'engine', a strong force nurtured by all involved actors, and supported by the collaborative na-

¹²r

ture of their relationships. It has the potential to incentivize researchers to step forward, and mobilize them to contribute to the team with their own knowledge, experience and expertise. In sum, collective leadership in science, is a form of art as much as it is a science.

The problem The classical leadership model¹³ relies on the power of senior authorities (be they academicians, principal investigators, research directors, group leaders, supervisors or mentors), and is supported by a strong hierarchy of roles (assumed by the researchers). As such, it has significant limitations for younger scholars, because it often restricts personal development and advancement along the institutional ladder, while it also inhibits inclusivity and diversity. In addition, it frequently prevents efficient circulation of knowledge, and optimal utilization of expertise within the team. Hence the need for collective leadership since it promotes sharing of opinions and responsibilities, joining forces in accountable decision-making, and honest, genuine engagement by each individual. A major contribution of the collective leadership approach is the following shift: from cooperation relying on roles and positions, to cooperation relying on contributions and responsibilities within the group.

The challenges The decision-making process which is concentrated in a single leader (or a handful of authorities) often produces imbalances. Simply put, fewer people move at a slower pace and serve as ineffective driving force in the struggle to catch-up with the fast technological developments. Researchers working in such environments are compelled to invest excessive energy in order to make their voices heard, their opinions considered, their suggestions and proposals valued. In addition, hierarchy of authors in some branches of science (marked by rigid lineup of distinct authorship positions within publications) is strongly reinforced, often inhibiting individual recognition, as

well as autonomy and career advancement of young scientists, and is thus not highly motivating or empowering. In fact, young global scholars are experiencing similar challenges, regardless of the specific research field, organizational setting and geopolitical context because “the difficulty of breaking down silos”, “the existing hierarchies”, “as well as preference for seniority over talent” often gets in the way of success¹⁴. So, the collective leadership model will offer a framework to overcome these issues and enable more equitized and well-balanced work environment.

The solutions Here, we offer a practical guideline of potential steps and activities, which could help scientists to grow as collective scientific leaders, and mark a successful start of their academic career. The activities should start from the self and suggest practices for self-analysis and personal improvement (for more elaborated considerations on the topic please refer to “Science and the Self” section). The strategies include: active listening with reflection and evaluation of absorbed knowledge; active learning with identification of problems and finding solutions; tracking personal motivation, drive and inspiration; improving communication with others; acquiring efficiency in multi-tasking (to handle research, relations, teaching or administration); all the while remaining a role model (professional as much as ethical). However, the importance of the scientific and educational institutions should also be emphasized, as they provide information, teach methodologies and offer various tools for acquiring knowledge and personal improvement. Later on, the process should be oriented towards the surroundings and the wider environment to include tasks as: shaping a clear vision and providing concise instructions for future; efficient commu-

nication with the group members; engagement and inspiration of teammates; frequent consultations with colleagues; collection of diverse opinions and ideas; evaluation of priorities and available solutions with smart delegation of tasks; and finally their smooth execution. Providing support to juniors, while helping out the senior colleagues. Establishing new (multinational and multidisciplinary) connections and nourishing the existing ones (via joint scientific events). Setting common challenges, shaping them as solvable goals, and enforcing fair rules. Recognizing and rewarding each success of others, each step of advancement, completion of each and every goal, no matter how small.

Envisioned as such, collective leadership in science will contribute toward healthy working environment and trustworthy relations between individuals. In time, the collective leadership can become a lifestyle cultivated within the group (instead of a power, concentrated in a single individual). The collective mindset would create awareness about the importance of scientific work (towards a greater good of humanity), promote engagement (in one’s own close community) and will also enhance the meritocratic recognition and advancement in career paths. As a result, personal and societal progress may follow. In large steps and quantum leaps, catching up with the technological and scientific developments.

¹²Leopold Leadership Program. (2018). Collective Leadership: Linking Knowledge to Action. *Stanford Woods Institute for the Environment*. Retrieved at: <https://stanford.app.box.com/s/eitjebzefac0e1of5lg05zo8wkz9axiq>

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Appendix I

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InterAcademy Partnership (IAP)

Under the umbrella of the IAP, more than 140 national, regional and global member academies work together to support the vital role of science in seeking evidence-based solutions to the world's most challenging problems. In particular, IAP harnesses the expertise of the world's scientific, medical and engineering leaders to advance sound policies, improve public health, promote excellence in science education, and achieve other critical development goals. More info available at www.interacademies.org and *@IAPPartnership* on Twitter.

Global Young Academy (GYA)

The GYA was founded in 2010 with the vision to give a voice to young scientists around the world. By empowering early to mid-career researchers to lead international, interdisciplinary, and intergenerational dialogues, the GYA mobilises talent from six continents for capacity-building, mentoring, engaging in science policy and improving the existing research environment. Members are selected by present members of the GYA for their demonstrated excellence in scientific achievement and their commitment to service to society. Currently, there are 200 GYA members and 258 alumni from 83 countries: Approximately half of members come from low- and middle-income countries. Many GYA members are likely to become the next generation of national and in-

ternational science leaders. The administrative Office receives its core funding from the German Federal Ministry of Education and Research (BMBF) and is hosted at the German National Academy of Sciences Leopoldina in Halle (Saale), Germany. More info available at www.globalyoungacademy.net and *@GlobalY-Academy* on Twitter.

Knowinnovation (KI)

Knowinnovation facilitates workshops that collect scientists from different disciplines together to redefine the challenges of a complex question and catalyze each other's thinking to create radically innovative research proposals. KI runs workshop events for national funding organizations, as well as working directly with institutions and universities to accelerate scientific innovation. Inclusive Innovation, an initiative of Knowinnovation, designs and facilitates inclusive science leadership workshops for the African Science Leadership program (ASLP) and the ASEAN Science Leadership Program (ASEAN-SLP) and for various global leadership events sponsored by the Global Young Academy (GYA) and InterAcademy Partnerships (IAP). More info available at www.knowinnovation.com and *@knowinnovation* on Twitter.

