

INAUGURAL EDITORIAL

The important role of the Engineering Education Review in enabling the paradigm shifts that are urgently required in engineering education

Marlene Kanga*

World Federation of Engineering Organizations, Paris 75015, France

It is an honor and a pleasure to contribute to the first edition of the *Engineering Education Research* (EER) Journal as one of the inaugural Chief-Co-Editors of this prestigious publication. As the first English language Journal on engineering education to be published in China, this publication will be a bridge for sharing knowledge and information across the world.

This Journal plays an important role in activating the United Nations Education Science and Cultural Organisation (UNESCO) Open Science Recommendations,^[1] which were approved by the UNESCO General Conference in November 2021. The Journal enables the transfer of knowledge to developing countries so that there is equal access to the latest trends in engineering education.

The relevance of this Journal is more important than ever in supporting engineering educators to develop the next generation of engineers and the essential skills that they will need to deal with increasing challenges that have no global boundaries. Engineers have a crucial role in developing the new technologies that will address climate change, especially in reducing the use of fossil fuels for energy generation and developing more efficient and reliable renewable sources of energy from wind, wave and solar sources. Engineers are also needed to support more efficient food development to counteract the impacts of climate change that are resulting in increasingly extreme weather, droughts and floods. They are also increasingly needed to design, build and maintain resilient infrastructure such as roads, bridges and railways, to withstand these natural disasters.

It is clear that more engineers are needed to address these challenges and that they must have the necessary skills to address these. Engineering education is therefore more important than ever.

The World Federation of Engineering Organizations recognized the role of engineers in its Paris Declaration^[2] and committed to work with UNESCO to “*Increase the numbers and quality of engineering graduates that meet the needs of sustainable development with rapidly changing technologies, in collaboration with educators, government and industry*”.

The second UNESCO Engineering Report “Engineering for Sustainable Development”,^[3] also highlights the crucial role of engineering in achieving each of the 17 United Nations (UN) Sustainable Development Goals (SDGs). The Report presents the case for the role of engineering and engineers for sustainable development to address basic human needs such as clean water, sanitation and access to reliable low-cost energy, as well as responding to natural disasters, designing and building resilient and other essential infrastructure.

The Report also acknowledges that engineering education itself needs to transform to ensure that engineers of the future have the right skills that are urgently needed. This means that while knowledge and skills involving the basic sciences and mathematics continue to be important, other skills that support the use of digital tools, the ability to research and adapt to new technologies, and a commitment to lifelong learning are also important. Engineering education outcomes need to ensure that

*Corresponding Author:

Marlene Kanga, World Federation of Engineering Organizations, 1 Rue Miollis, Paris 75015, France. Email: marlenekanga@bigpond.com; <https://orcid.org/0009-0000-5419-0338>

Received: 26 August 2023; Revised: 06 September 2023; Accepted: 14 September 2023; Published: 06 October 2023

<https://doi.org/10.54844/eer.2023.0445>

© This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License, which allows others to copy and redistribute the material in any medium or format non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

graduates have the necessary skills to be creative, think critically, develop complex problem-solving skills, work collaboratively in teams and be aware of the impact of their work on people and the planet and advance sustainable development. Engineers also need to have the ability to reflect on the consequences of their work with a broad ethical viewpoint that encompasses not only environmental but also social and economic impacts. This requires a transformation of the engineering education curriculum, pedagogies and approaches that have been in place for the last 50 years, to ensure that future engineering graduates meet the needs of employers, and importantly of society.

I am proud that I initiated a partnership project with the International Engineering Alliance (IEA), as President of the World Federation of Engineering Organizations, to review the Graduate Attributes and Professional Competencies (GAPC) Framework, the international benchmark for the accreditation of engineering programs that is the basis for mutual recognition of engineering qualifications and professional credentials across more than 30 nations that are signatories of the IEA. The project commenced in late 2019, and the IEA signatories unanimously approved the reviewed benchmark at their annual meeting in June 2021.^[4] This was a remarkable achievement since the entire review was completed with virtual meetings, during the coronavirus disease (COVID-19) lockdowns. The review was the most significant that had occurred since the Benchmark was first established in the late 1980s.^[5]

There was extensive consultation with engineering educators, industry employers and women engineers through the Federation's international partners including the International Federation of Engineering Education Societies (IFEES), the Global Engineering Deans Council (GEDC), the International Federation of Consulting Engineers (FIDIC) and the International Network for Women Engineers and Scientists (INWES). UNESCO was also a key partner in this project.^[6] This was the first time that such extensive consultation had occurred for the review of the engineering education benchmark. The GAPC has been translated into the six official UNESCO languages to facilitate a greater understanding of the Framework and extend its utilization around the world.^[7]

A second major change that is required in engineering education, and also identified in the second UNESCO Engineering Report, is the need to ensure that engineering is a diverse and inclusive profession, to attract the brightest minds, male and female, to study engineering. This key requirement is addressed throughout the reviewed GAPC Framework. However extensive research and learning will be required in the next few years to transform and adapt the engineering curriculum, pedagogies and assessment framework, to ensure that engineering is appealing to

all students. The contributors to this Journal have an important role for engineering researchers and educators to share their practices and learning to facilitate this process.

A third challenge for engineering educators and researchers is to prepare future engineers for the rapid technological advances that are taking place. Artificial Intelligence, Machine Learning, advances in data analytics and the emergence of new engineering disciplines require engineering educators to be agile in developing their programs and to ensure that their students develop an appetite and skill for lifelong learning. The reviewed GAPC Framework includes these requirements. This Journal will have an important role in facilitating improved and innovative engineering education practices to achieve these objectives.

As the Fourth Industrial Revolution accelerates in developing countries in Africa, Asia and Latin America, there will be an increasing need for engineering education to include new topics and skills that respond to the demands of emerging technologies.^[8]

In these regions, there is an imperative to leapfrog traditional economic development pathways. Emerging economies do not need to invest in legacy infrastructure and can take advantage of technological advancements. For example, mobile phones and Wi-Fi can replace the need for fixed-line telecommunication networks. Distributed energy generation using solar and wind sources can lead to distributed energy networks, especially in remote and regional areas, reducing reliance on expensive conventional grid distribution.^[9] Renewables, including solar, wind, hydropower and geothermal could account for over 80% of new power generation capacity in 2030, according to the IEA. However, under the Sustainable Africa Scenario, an additional four million jobs will need to be filled by 2030.^[10] It is expected that engineers will be required to fulfill the promise of this Scenario. Engineering education has a critical role in ensuring that engineering graduates have the necessary skills for renewable energy generation and other new industries, especially in Asia, Africa and Latin America where there is the greatest need for more engineers.

Continuous Professional Development (CPD) programs for engineers and educators will also become increasingly important. The World Federation of Engineering Organization has established an online training portal, the 'WFEO Academy' which provides access to CPD online. These consist of webinars that have been delivered by world experts and are reproduced in the training portal to be accessed by all at no cost.^[11]

This Journal will also have an important role in supporting engineering academics in their professional development, to understand the essential changes that are needed,

especially to meet the requirements of international engineering education benchmarks, to meet the demands of industry and government employers, and to ensure that their engineering students have the required skill to advance sustainable development. It is anticipated that the Journal will support engineering educators in developing curricula and teaching tools that appeal to all students, especially women so that the diversity of engineers is increased. Engineering educators will also be supported in developing programs that ensure that engineers have essential skills in communications and teamwork, in addition to critical thinking, systems analysis, creativity and innovation. Importantly the Journal is expected to support engineering educators in developing a capability and skill for lifelong learning in their students.

Over time, we expect that the Journal will make a significant contribution to advancing the UN SDGs in supporting engineering educators with the paradigm shift required in developing the next generation of engineers.

DECLARATION

Conflict of Interest

Kanga M is the Co-Editor-in-Chief of the journal. The article was subject to the journal's standard procedures.

REFERENCES

1. UNESCO. UNESCO Recommendation on Open Science. UNESCO Digital Library. Accessed August 11, 2023. <https://unesdoc.unesco.org/ark:/48223/pf0000379949.locale=en> November 2021
2. World Federation of Engineering Organizations. Paris Declaration: Advancing the United Nations Sustainable Development Goals through Engineering. Accessed August 11, 2023. http://www.wfeo.org/wp-content/uploads/declarations/WFEO-UNESCO-Paris_Declaration.pdf
3. UNESCO. Engineering for Sustainable Development. Accessed August 11, 2023. <https://unesdoc.unesco.org/ark:/48223/pf0000375644>
4. International Engineering Alliance. Graduate Attributes and Professional Competencies Framework. Accessed August 11, 2023. <https://www.ieagrements.org/assets/Uploads/Documents/IEA-Graduate-Attributes-and-Professional-Competencies-2021.1-Sept-2021.pdf>
5. International Engineering Alliance. Graduate Attributes and Professional Competencies Framework, Appendix 4. Accessed August 11, 2023. <https://www.ieagrements.org/assets/Uploads/Documents/IEA-Graduate-Attributes-and-Professional-Competencies-2021.1-Sept-2021.pdf>. OP. cit
6. Committee on Education in Engineering (CEIE) - GAPC Consultation. International Engineering Alliance publishes approved revised Graduate Attributes and Professional Competencies Framework (GAPC), supported by UNESCO and WFEO. Accessed August 11, 2023. <http://www.wfeo.org/wfeo-ceie-gapc-consultation/#IEA-publishes-approved-revised-GAPC>
7. Engineering for Sustainable Development. International Engineering Alliance published translation of the Graduate Attributes and Professional Competencies Framework. Accessed August 11, 2023. <https://www.wfeo.org/international-engineering-alliance-published-translation-of-the-graduate-attributes-and-professional-competencies-framework/>
8. World Economic Forum. The Future of Jobs and Skills in Africa Preparing the Region for the Fourth Industrial Revolution. Accessed August 11, 2023. https://www3.weforum.org/docs/WEF_EGW_FOJ_Africa.pdf
9. Morgante E, Wallace-Stephens F. Pathfinding: The future of work in Sub-Saharan Africa-The Royal Society for Arts, Manufactures and Commerce. Accessed August 11, 2023. https://www.thersa.org/globalassets/_foundation/new-site-blocks-and-images/reports/2021/08/pathfinding_the_future_of_work_in_sub_saharan_africa.pdf
10. International Energy Agency. Africa Energy Outlook. Accessed August 11, 2023. <https://www.iea.org/reports/africa-energy-outlook-2022>
11. World Federation of Engineering Organisations WFEO Academy. Engineering Education Training. Accessed August 11, 2023. <https://wfeoacademy.com/>