



Promoting Excellence in Knowledge

# GHANA ACADEMY OF ARTS AND SCIENCES

## ANNUAL LECTURE IN THE SCIENCES, 2022



**TOPIC:**

### THE SCIENCE OF OWARE BOARD

**SPEAKER:**

**DR. NII NARKU QUAYNOR, FGA**

*Professor of Computer Science*

**CHAIRMAN:**

*Emerita Professor*

**ISABELLA AKYINBAH QUAKYI, FGA**

*Vice President, Sciences Section, GAAS*



**DATE:** THURSDAY OCTOBER 6 2022 | **TIME:** 5:30 PM  
**VENUE:** GHANA ACADEMY OF ARTS AND SCIENCES AUDITORIUM  
*#3 Research Crescent, Casely Hayford Road, Airport Residential Area, Accra*

**LIVE ON**



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ABOUT THE CHAIRPERSON  
*Emerita Professor*  
**ISABELLA AKYINBAH QUAKYI, FGA**  
*Vice President, Sciences Section, GAAS*

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**E**merita Professor Isabella Akyinbah Quakyi is a Professor of Immunology and Parasitology, University of Ghana (UG). The first Emerita Professor in the Sciences at the University of Ghana. Educated at Achimota Secondary School (64 year Group), Accra. She holds a Bachelor of Science (Honors) degree in Human Biology and Immunology from university of Surrey, England, 1973, an MSc in Applied Immunology from Brunel University, Uxbridge, Middlesex, England 1978, and a PhD in Immuno-parasitology from the London School of Hygiene and Tropical Medicine (LSHTM), England, 1980.

For the past four decades, she has taught and researched at the National Institutes of Health (NIH) in Maryland and Georgetown University, Washington DC, both in the USA, and University of Ghana (UG), Legon. Her teaching and research have focused on malaria immunity, immunoparasitology, immunopathology, immunodiagnosis, autoimmunity, molecular immunology and vaccine development. She co-initiated and co-led the first NIH International Center of Infectious Diseases Research (ICIDR), a research partnership between Georgetown University and University of Yaounde I, Cameroon (1990 – 2001). This program built enormous academic scholarship and research capacity in laboratory and field research in Cameroon. She attained Full Professorship of Immunology and Parasitology at UG in 2001.

At the University of Ghana she established the Immunology Unit at NMIMR 1980 -1983. She was the first female Director of the UG School of Public Health (UGSPH) and the Foundation Dean of UGSPH, also making her the first female Dean in the College of Health Sciences in the University of Ghana 2002-2007. At UG she built substantial international research capacity, academic scholarship, and the leadership needed to build capacity for Public Health. She remains passionate about Biomedical Research Development and Knowledge Translation. She has over 100 publications including books and scholarly articles.

She has served on numerous National and International Committees and Boards and received several awards; a former member of Ghana Health Service Council, and former UNESCO Chair for Women in Science and Technology in the West Africa Region. She won the 2014 Laureate African Union Kwame Nkrumah Award for Women in Science. She is the 2019 laureate for the Clara Southmayd Ludlow award by the American Society of Tropical Medicine and Hygiene (ASTMH). Women's World day 2021 recognized her as one of seven women in Science who have changed our world for the better. She is a Fellow of the Ghana Academy of Arts and Sciences and Fellow of the African Academy of Sciences.

**D**r. Nii Quaynor graduated from Dartmouth College in 1972 with B.A (Engineering Science) and received a Ph.D (Computer Science) in distributed systems in 1977 from S.U.N.Y at Stony Brook.

Dr. Quaynor worked with Digital Equipment Corporation, DEC, U.S.A from 1977 till 1992 building high-performance and fault tolerant systems. He returned to Ghana to initiate the computer science department at the University of Cape Coast, UCC, in 1979 and again to establish the first ISP in West Africa, operated by Network Computer Systems (NCS), in 1993.

He taught at microprocessor colleges of the International Center for Theoretical Physics (ICTP), Trieste, Italy in several developing countries in the '80s.

He led the formation of several regional technical institutions of the internet in the '90s that coordinate and administer the Internet in Africa today, including African Network Operators Group (Afnog), Afrinic, Africa's numbers registry, a community of African ccTLDs, Afild, African Research and Education Networks, Afren, African accredited Registrars, Afregistrar, organization of CERTs in Africa, Africacert and Dotafrica initiative

Dr. Quaynor has served on several Boards, Commissions, and Task Forces globally including ICANN, UN ICT Task Force, UN IGF-MAG, Global Commission on Internet Governance, ICANN Strategy Panel on Public Responsibility, National IT Agency, Ghana Interbank Payments and Settlements System, National Identification Authority, Ghana News Agency, Council of the University of Ghana, West and Central Africa Research and Education Network, Wacren, and the Electronic Communications Tribunal of Ghana.

He received the Internet Society's prestigious Jonathan Postel Service Award for pioneering work to advance the Internet in Africa in December 2007. He was inducted into the Internet Hall of Fame in August 2013 for his pioneering role in the development of the Internet in Africa. Dr. Quaynor received the Osagyefo Kwame Nkrumah Genius Award for Information Communication Technology in December 2014 and was also awarded ICANN's Multi-Stakeholder Ethos award in June 2015.

He is currently the Chairman of Ghana Dot Com, a Registrar, and an adjunct professor of Computer Science at the University of Cape Coast. He is a Patron of the Internet Society of Ghana, a member of the steering committee of the Blockchain Governance Initiative Network, (BGIN), and a Fellow of the Ghana Academy of Arts and Sciences.

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## SYNOPSIS

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### THE SCIENCE OF OWARE BOARD

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Oware board is considered a computational instrument in our scientific cultural heritage worthy of recall. The algorithms of three commonly played games are analyzed

It is demonstrated that the board we use for games today is a long forgotten mechanical computer which if used will strengthen mathematics in our society

Early mathematics education is important to success in many disciplines and some schools have gone far to import Abacus instrument in teaching. We do so not recognizing that Oware board, without any modification, is an equivalent computational instrument to Abacus

The games played in Ghana, their rules and underlying algorithms are worthy of preservation in cyberspace

These computer science research results are of theory of computation while the game algorithms are of artificial intelligence discipline. The physical board and the operation of the Oware instrument are in computer architecture

It is shown how to do arithmetic on the Oware board. We show how to represent 6 digit numbers, positive and negative, on the board and the special roles for the side pockets

The primitives that embody the rules for what is permissible on an Oware computer are defined. These primitives may be combined in human mechanical manipulation of stones on the board, to implement useful functions such as addition, subtraction, multiplication and division. The primitives permit a convention for cascading functions thus one may create a sequence of operations in an Oware computer program

The implementation of algorithms for common games played on the Oware board, (nante nante, abapa, naadole) are illustrated. The state space, heuristics, encoding of rules, moves and search methods are described. The implementations of Oware games in this activity have evolved from 1980s (Pascal programs) to 1990s (C programs with limited user interface) to those in 2000s (Objective C programs with extensive user interaction in interface).

## PROGRAMME OUTLINE

- **5:30 PM**  
**Welcome Address and Introduction of Chairman**  
*Prof. George Obeng-Adjei, FGA,*  
*Assistant Honorary Secretary, Sciences Section, GAAS*
  
- **Chairman's Remarks and Introduction of Speaker**  
*Emerita Professor Isabella Akyinbah Quakyi, FGA*  
*Vice President, Sciences Section, GAAS*
  
- **Lecture Begins**
  
- **Chairman's Closing Remarks**
  
- **Honorary Secretary's Remarks**
  
- **Closing [ Guests to pick up bagged refreshments in the foyer ]**

## ANNUAL LECTURES

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The Academy instituted the Annual Lectures in the Sciences and Humanities in 1993, with a view to creating a platform where Fellows could take turns in addressing topical issues in the humanities and the sciences.

Annual Lectures delivered in the Sciences and the Arts from 2003 are as follows:

### SCIENCES

- 2003 Water: A Crisis in Development; *Letitia E. Obeng*.
- 2005 The Landscape industry in Sustainable Environmental Management; *J.C. Norman*.
- 2006 Avian Influenza Symposium, GAAS and College of Physicians and Surgeons Collaboration.
- 2007 Who is a Sickle Cell Person; *S. K. Addae*.
- 2008 Managing the Impact of Climate Change on Food Security: Some Post-Production Options for Ghana; *S. Sefa-Dedeb*.
- 2009 Technology for Development in Resource-Poor Countries, *W. S. Albassan*.
- 2010 The Threat of Counterfeit and Substandard Drugs to Healthcare Delivery in Developing Countries; *I. Addae-Mensab*.
- 2012 Clay; Its Benefits to Mankind; *V. P. Y. Gadzekpo*.
- 2013 Naturally Occurring Radioactivity in Our Homes; *Aba Bentil Andam*.
- 2015 Galamsey: Effects on Soil Productivity; *Y. Abenkorab, and E. Owusu-Bennoah*.
- 2017 Stress and Rest: Pharmacodynamic Modulation for Sustainable Human Health; *Arthur C. Sackeyfio*.
- 2018 Plants and Human Development; *G.K.S. Aflakpui*.
- 2019 Is Ghana on the Brink of Ecological Suicide? *Rose E. M. Entsua-Mensab*.
- 2020 Biodiversity Conservation, Genetic Resources, Gene Sequencing and the Nagoya Protocol: Challenges, Dilemmas and Opportunities; *Alfred A. Oteng-Yeboah*.
- 2021 Self And Non-self: The Marvel Of The Human Immune System; *Isabella A. Quakyi*

### ARTS

- 2004 Language, the Mass Media and Democracy in Ghana; *K. Yankab*.
- 2005 Parliamentary Vetting and our Constitutional Democracy; *G. K. Acquab*.
- 2007 Military Technology, the Nkrumah Government and Ghana Armed Forces; *S. K. Addae*.
- 2008 The African Family in Crisis: The Case of Ghana; *G. K. Nukunya*.
- 2009 Signposts to Healthy Politics in Ghana; *J.R.A. Ayee*.
- 2010 Language, Africa, and the Art of being Human; *M. E. Kropp-Dakubu*.
- 2012 Peaceful Electoral Environment and Elections: The Role of Stakeholders; *E. Asante*.
- 2013 The Constitutional Phrase 'We the People' and the Politics of Inclusion; *K. Gyekye*.
- 2016 Scholarly Publishing in Africa and the Role of the Open Access Initiative (OAI); *A. A. Alemna*.

- 2017 Of Demolished University Gates in a Fourth Republic: Is Academic Freedom under Siege; *K. Yankab.*
- 2018 Migration, Farmer-herder Conflicts and Insecurity in Ghana: Unravelling the Recent Violent Incidents in The Afram Plains; *Prof. Steve Tonab.*
- 2021 Divinity and Epidemiology: Religion and Public Health in The History of Pandemics in Africa (1918-2020); *J. Kwabena Asamoab-Gyadu.*
- 2022 Right to Information and Its Impact on Ghana; *Justice Sir Dennis Dominic Adjei.*

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## THE ACADEMY

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**T**he Ghana Academy of Arts and Sciences is Ghana's Premier Learned Society. It was founded in November 1959 by Government Instrument of Incorporation. Its aim is to bring together the highest level of intellectuals, experts, professionals in the country to constitute a 'Think Tank' in the Arts and Sciences to enable it advise government and other relevant bodies on issues of importance to national development.

### ***Mission:***

The mission of the Ghana Academy of Arts and Sciences is to encourage the creation, acquisition, dissemination and utilisation of knowledge for national development through the promotion of learning.

### ***Objectives:***

#### ***The Academy's objectives are to:***

- Promote the study, extension, and dissemination of knowledge of the Arts and Sciences;
- Promote the establishment and maintenance of proper standards of endeavour in all fields of the arts and sciences;
- Recognize outstanding contributions to the advancement of the arts and sciences in Republic of Ghana;
- Contribute actively to the advancement of Ghana and Africa in particular and the world in general by examining and addressing issues of development; and
- Do any other things that are conducive or incidental to the attainment of all or any of the foregoing objectives.

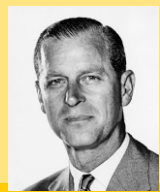








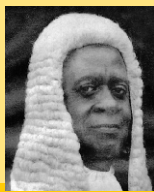
**PRESIDENTS**  
GHANA ACADEMY OF ARTS AND SCIENCES  
| 1989 - 2022 |



Duke of Edinburgh, Prince Philip, FGA  
1959 - 1981



Dr. Kwame Nkrumah, FGA  
1961 - 1966



Mr. Justice N.A. Otienu, FGA  
1969 - 1972



Prof. E.A. Boateng, FGA  
1973 - 1976



Prof. C.O. Essom, FGA  
1977 - 1980



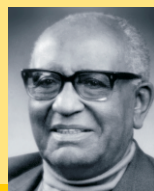
Prof. E.G.T. Torto, FGA  
1981 - 1982



Most Rev. Prof. K.A. Dickson, FGA  
1983 - 1986



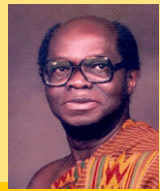
Dr. E. Evans-Anom, FGA  
1987 - 1990



Rev. Prof. C.G. Baeta, FGA  
1991 - 1992



Prof. D.A. Bekou, FGA  
1993 - 1996



Prof. J.H. Kwabena Nketia, FGA  
1997 - 1998



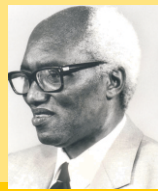
Prof. Fred T. Sai, FGA  
1999 - 2002



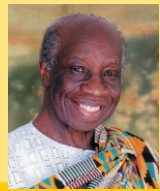
Nana Dr. S.K.B. Asante, FGA  
2003 - 2006



Dr. Letitia E. Obeng, FGA  
2007 - 2008



Prof. Reginald Fraser Amoneko, FGA  
2009 - 2010



Prof. E.K.A. Akotoy, FGA  
2011 - 2014



Prof. Akiagga Sawyer, FGA  
2015 - 2016



Prof. Aha Benfil Andam, FGA  
2017 - 2018



Prof. Henrietta J. A. N. Mensa-Bonsu, FGA  
2019 - 2020



Emeritus Prof. Samuel Seta-Dedei, FGA  
2021 - 2022

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