MASENO UNIVERSITY
FOUNTAIN OF EXCELLENCE

DIRECTORATE OF RESEARCH AND INNOVATIONS

2023
NEWSLETTER

# BIANNUAL RESEARCH NEWSLETTER

JANUARY-JUNE, 2023

# MESSAGE FROM DIRECTOR, RESEARCH AND INNOVATIONS

## PROF. COLLINS OUMA

The Directorate of Research and Innovations at Maseno University, headed by **Prof. Collins Ouma**, is tasked with the responsibility of supporting research, innovations, publications and hosts the Maseno University's Scientific and Ethical Review Committee (MUSERC).

Over the last final half year (2022-2023), we have continued to be highly engaged with various activities and we have the opportunity to highlight some of the research-related works conducted by some of our staff. Just to highlight the successes over the last 6 months, the Directorate has been able to generate externally research grants amounting to about **KShs. 40,000,000** from both research grants and ethics fees. In addition, our academic staff and students have been able to publish in peer-reviewed journals, a total of **115** additional publications. We still continue with the process of actualizing several innovations, some of which are moving to commercialization. We still continue to nurture the Maseno University Business Incubation Center (MUBIC) so that more incubators can bring to reality their innovations through the Center.

In the current newsletter, we focus on the research activities for three key researchers: Prof. David David Miruka Onyango (Zoology), Dr. Benson Nyambega (Biochemistry) and Dr. Lilian Wanzare (Computer Science). Their respective research span identification of biomarkers for various cancers and research in infectious and non-infectious diseases, and use of artificial intelligence to solve problems associated with the disabled populations. The Directorate remains enthusiastic that it will highlight more researchers and their activities within the next financial year.

Finally, we take note that more staff, whether academic or non-academic currently recognize that research is a core mandate of the University, and the interest to be involved in research and community outreach activities has never been this high.

**Prof. Collins Ouma, PhD, MKNAS, FAAS**

# 1 PROF. DAVID MIRUKA ONYANGO (ZOOLOGY)

**Profile:**

**David Miruka Onyango (PhD)** is currently an Associate Professor of Cell, Molecular Microbiology and Biotechnology at Maseno University, Department of Zoology. He has over 14-year of teaching and research experience in the field of Cell, Molecular Biology and Biotechnology. His research interest are in the areas of Molecular epidemiology and antimicrobial drug resistance in gastroenteritis microbes in human, animals, Molecular mechanisms, and regulation of genes in prokaryotes and eukaryotes. He has a Post-Doctoral qualification from the University of Kwazulu Natal in the field of Molecular Pharmacology and Drug discovery. He is the immediate Ag. Director of Science Technology and Innovation at Maseno University and the coordinator of Cell and Molecular Biology activities in the department. He has attracted a number of research grants through competitive bids that have enabled him to develop, equip and initiate an operational Molecular Biology laboratory at the institution where he has trained over 5 PhD and 18 MSc students to completion. His expertise has been sort nationally and internationally as a reviewer of the National Research Funds-Kenya (NRF)(Health and Biological disciplines), National Consortium of Science, Technology and Innovation (NACOSTI) (Biological discipline) and as editor of a number of peer reviewed journals as well as adjudicator of science research projects to tertiary institutions. Due to his vast knowledge in his subject area, he has secured appointments by various university senates as external examiner for both undergraduate and postgraduate student's examinations and thesis. Prof. Onyango has published over 45 peer reviewed research articles and one university grade book and laboratory manual, 2 book chapters with one additional one in the pipeline, and 1 policy brief. In addition, he has 3 published research project reports. He has attended over 15 research conferences and workshops for oral and poster presentations. He has equally organized 11 workshops and conferences nationally and internationally. He has several scholarship awards and nomination to the prestigious Marquis Who's is Who in the World: DAAD- Germany and the South Africa Medical Research Council. Prof. Onyango has over 8 years' experience in Strategic leadership and is currently enrolled for a course on International Project Management and Resource Mobilization. He is a member of several professional bodies like the International Brain Research Organization, European Society of Clinical Microbiology and Infectious Diseases, and a Task Force Member of Novatris Non –Typhoid Vaccine Development. He is currently a member of the Kenya National Academy of Science. In terms of research collaboration, Prof. Onyango, has establish collaboration with the Nottingham University department of oncology UK, University of Sterling UK, Cambridge University, Otto Von Universitate Germany, University of Kwazulu Natal and Kenya Medical Research Institute, Kenya Marine and Fisheries Institute among others.

Prof. Onyango has been involved in the following research areas:

**Project Title:** **Evaluation of blood and urine biomarkers for early detection, diagnosis, monitoring and management of prostate cancer in Western Kenya**
**Duration:** 3 Years (2020 –2023) (Project Yet to start due to delayed release of funds)
**Collaborators:** Prof. Asha G. Ngwena, Dr. Elias Melly, Dr. Willis Oyieko, Dr. Kritka Patel, Dr. Mary Onyango, Dr. Macharia Benson Ndegwa
**Research Area:** Cancer Research
**Funder:** National Research Fund (NRF)
**Outcome:** Study is Yet to Start

**Project Title:** **Affordable Green Energy from Agricultural Wastes for Improved Community Livelihood**
**Duration:** 3 Years (2020 – 2023) (Project Yet to start due to delayed release of funds)
**Collaborators:** Dr. Agatha Otieno, Dr. Beatrice N. Onyango, Dr. Mary Anyango Oyunga, Dr. David Masinde, Dr. Lucy Amanya Mutuli.
**Research Area:** Community Nutrition
**Funder:** National Research Fund (NRF)
**Outcome:** Study is Yet to start

**Project Title:** **Affordable Green Energy from Agricultural Wastes for Improved Community Livelihood**
**Duration:** 3 Years (2019-2020) (Project still on-going)
**Collaborators:** Prof. Chrispin O. Kowenje, Prof. Aruon Ogindo, Dr. Obange, Dr. Scolastica , Dr. , Mr. Richard Arwa, Dr. Kuloba
**Research Area:** New and Re-Newable Energy
**Funder:** National Research Fund (NRF)
**Outcome:** Project is currently on going.



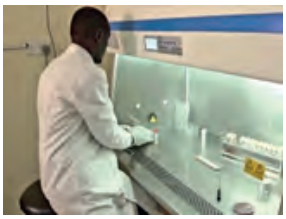


Project Title: Molecular application of protein phosphatase 2A in Cyanobacteria microcystin quantification and degradation in water purification systems (Projected extended due to COVID and late release of funds).
Duration: 3 Years (2016-2019)
Collaborators: Prof. Chrispin O. Kowenje, Dr. Paul Orina Sawe, Ms. Cecillia Muthoni, Dr. Rose K. Ramkat, Dr. Dorcus Lusweti, Dr. Henry Lungayia
Research Area: Cancer Research
Funder: National Research Fund (NRF)
Outcome: This study intended to determine the involvement microcystin toxin (MC) as an additional risk factor to Primary liver (PLC) cancer occurrence and progression in communities living along Lake Victoria region (Kenya) and its environs. It was found that the there was an increase in cyanobacterial bloom in Lake Victoria, Nyanza Bay, with the concentration levels of microcystin going up to 21.4µg/L, which is high above the World Health Organization (WHO) recommended levels. This poses a

health risk to communities who depend on lake water for domestic use. In addition, high microcystin concentration levels were equally recorded in fish liver, kidneys, muscles and gills. This acted as source of contamination to human when used as food. The study also intended to establish association between the prevalence and levels of microcystin in PLC cases; the levels of serum serine-threonine phosphatases (PP 1 and PP 2A) in PLC cases; and the association between serum-microcystin and the occurrence of PLC. We conclude that continuous exposure to MCs could be a risk factor to PLC development.







**Project Title:** **Arresting lipid oxidation and browning of sundried products marketed in western Kenya using low cost fish processing and preservation technologies**

**Duration:** 3 Years (2011-2013)

**Collaborators:** Prof. Andrew Oduor, Prof. Chrispin Kowenje, Ms. Rosemary Owigar, Dr. Petronilla Otuya, Prof. Chrispin Kowenje, Dr. Anthony Sifuna, Dr. Henry Lunyagia

**Research Area:** Post-Harvest loses

**Funder:** National Consortium for Science, Technology and Innovation (NACOSTI)

**Outcome:** This study set out to evaluate effectiveness and quality of R. argentea processed by sun-drying along the shores of Lake Victoria, Kenya and the findings indicated contamination of fish with E. coli, Proteus, Salmonella that were resistance to a spectrum antimicrobial in different markets and beaches an indication that sun-drying on the ground spread nets and even racks did not reduce their contamination with these microbes. We also determined the water quality in selected fishing beaches of Lake Victoria, Kenya with a view to report the possible pollution levels. All parameters assessed showed significant differences across sampling sites and depth except pH, which did not vary significantly with distance from lakeshore. Further, all parameters did not show a clear pattern with respect to distance from the lakeshore possibly due to adequate mixing in the gulf. There is need for further water quality monitoring by seasons to inform policy decisions towards sustainable lake exploitation.





**Project Title:** **Determination of the prevalence and sources of diarrheagenic bacteria contaminating fish, water and the environment in the Lake Victoria basin, Kenya**
**Duration:** 1 Year (2012)
**Collaborators:** Dr. Anthony Wabwire Sifuna
**Research Area:** Post Harvest loses
**Funder:** International Foundation for Science (IFS)
**Outcome:** The study compared E. coli recovered from human, fish products, domesticated animals, and the environment within the Lake Victoria basin on their basis of their antimicrobial susceptibility profiles. The finding was that based on the discriminant analysis (DA), most of the fish isolates were misclassified into soil category, probably due to groups displaying similar Multiple Antibiotic Resistance (MAR) profiles. On the other hand, human isolates had the highest score of 0.55. The finding suggests that soil may be an important source of bacterial contamination of fish. Similarly, resistance to antibiotics is widely prevalent among human, environment and domesticated animals within the Lake Victoria basin.

**Project Title:** **Vibrio cholera diversification and clonal analyses along Lake Victoria Kenya**
**Duration:** 3 Years (2012-2014)
**Collaborators:** Dr. Roselida Achieng Owuor
**Research Area:** Microbial epidemiology
**Funder:** National Consortium for Science Technology and Innovation (NACOSTI)
**Outcome:** The study set to investigate the type of pathogenic Vibrio strains from water and stool samples collected from Migori, Sondu-Miriu, Nyando and Yala region in Western Kenya. The study showed the presence of V. cholera (Ogawa and Inaba) in water and human stool samples. Type B *V.vulnificus* was detected in water samples from River Migori.

## Other additional funded projects

1. (2018/2021) Morphological characterization, yield determination and proteomic analysis of selected Bambara groundnut landraces in Lake Victoria Basin. (Co-PI) $ 5,000.
2. (2016/2018) - Antimicrobial profile and genetic diversity of *Pseudomonas aeruginosa* isolates among patients at JaramogiOgingaOdinga teaching and referral hospital in western Kenya – Co- PI- NACOSTI - $ 2,000.
3. (2016/2018) - Profiling and pathogenicity of *Ralstoniasolanacearum* of tomato and its control using *Sennadidymobotrya AND MoringaOliefera* plant extracts. Co- PI – NACOSTI -$2,000.
4. (2013/2016) Analysis of ERα and ERβ haplotypes syndromes in HIV patients treated with protease inhibitors (South African RANDS). NRF- $ 72,000
5. (2010/2012)-An interactive effects of high stocking density and amarantus-enriched feed on growth performance and fatty acids tissue profile in Nile Tilapia (NCST/2012/2013 FY). Co-funding-$2,500.
6. Surveillance study of antimicrobial resistance in *Salmonella Spp, CampylobacterSpp, Escherichia coli and Enterococcus Spp* gut of healthy food animals and retail meat outlets in selected regions in Kenya – FAO (Co-funding).
7. (2009/2010)-Investigation of environmental factors that contribute to survival and emergence of epidemic *Vibrio cholerae* strains in cholera-prone regions in Kenya Co-funding, Swiss Francs– 110,000
8. (2010/2012) - Genotypic characterization and antimicrobial resistance mechanisms of Escherichia coli recovered from fish landing environment in Dunga and Sirongo beaches of Lake Victoria –Co- funding, NCST $ 2,500.

# 2 DR. BENSON NYAMBEGA (BIOCHEMISTRY)

**Profile:**

Dr Benson Nyambega, is currently a Senior Lecturer at the Department of Medical Biochemistry, School of Medicine, Maseno University, Maseno, Kenya. Dr. Nyambega holds a PhD in Biochemistry from the University of Buenos Aires, Argentina and postdoctoral training in Trypanosome Molecular Biology from the University of Heidelberg, Germany.

His long-standing research in infectious disease research has provided a springboard into non-communicable disease (human neoplasms) research as informed by the reality that majority of trans-Saharan African Countries are witnessing interplay between infectious disease and social determinants with non-communicable diseases. His research hypothesizes likely association between biological/behavioral factors and certain predominant human cancers. To that end, he has received funding from the National Research Fund (Kenya) and established a state-of-the-art Cancer molecular research laboratory within the Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH in Kisumu City. He has also received catalytic funds for Cancer for Cancer Data Systems Development from BIO Ventures for Global Health within the framework of the African Consortium for Cancer Clinical Trials (AC3T). In the Cancer Data Systems Development project, he leads a team focusing on cancer registries as unique platforms capable of generating information for various uses including in epidemiological research, evaluation of cancer control measures and, in monitoring standards of clinical care. It is expected that data generated over time is accessible and meets certain minimum threshold in their collection, coding, presentation and supports archiving of clinical samples for research.

Dr. Nyambega's long-term goal is to be a leading cancer translational research scientists in Africa and ensure that the JOOTRH becomes a center of excellence in the provision of high-quality health services, biomedical training and population-focused research. The Cancer Research laboratory is the first of its kind in Kenya and is expected to sustain its activities through good leadership, mutual partnerships and collaborations.

With funding from the National Research Fund Kenya, Dr. Nyambega has steered the establishment of the Western Kenya Cancer Care and Research Center in Kisumu, Kenya. The state-of-the-art facility located within JOOTRH.

**Dr. Nyambega has been participating in the following research projects:**

The Parent award established the CaRE2 Health Equity Center at University of Southern California (MPIs: Dr. John Carpten and Dr. Mariana Stern) was established in 2018 through funding from the NIH/NCI collaborative partnership among University of Florida, Florida A&M University and University of Southern California (U54CA233444, U54CA233396, U54CA233465). The CaRE2 Center is a bi-coastal center, which combines cutting-edge expertise in and resources for translational research, cancer research training and education, innovative community initiatives, and process and outcome evaluation for reducing cancer disparities among Blacks and Latinos.

## Supplemental Research Project.

**Title:** Biological Determinants of Quality of Life Among Prostate Cancer Survivors in Kenya and Nigeria

**Background:** Beyond the United States, prostate cancer is the most prevalent male malignancy and the leading cause of cancer deaths among Central American, Caribbean, and Sub-Saharan African men.1 Although several factors account for these disparities, the constitutive biological factors associated with African ancestry significantly contribute to the risk of development, aggression, and poor outcomes of CaP in Black.2-5 Although, Black men in the Americas have their ancestral roots in the Africa 6,7 and the proportion of the African genetic ancestry is associated with CaP aggression 8,9, there is paucity of data on the biological determinants of aggression and poor clinical outcomes of CaP in indigenous, resident African men10. To identify the biological drivers of the aggressive phenotype in this high-risk population, our team has utilized transcriptomics analysis of prostate tumor of West African men to identify genes associated with high-grade disease and identified unique upregulation of TDO2 (tryptophan 2,3-dioxygenase) (see Figure 1) in CaP of indigenous Africans.11

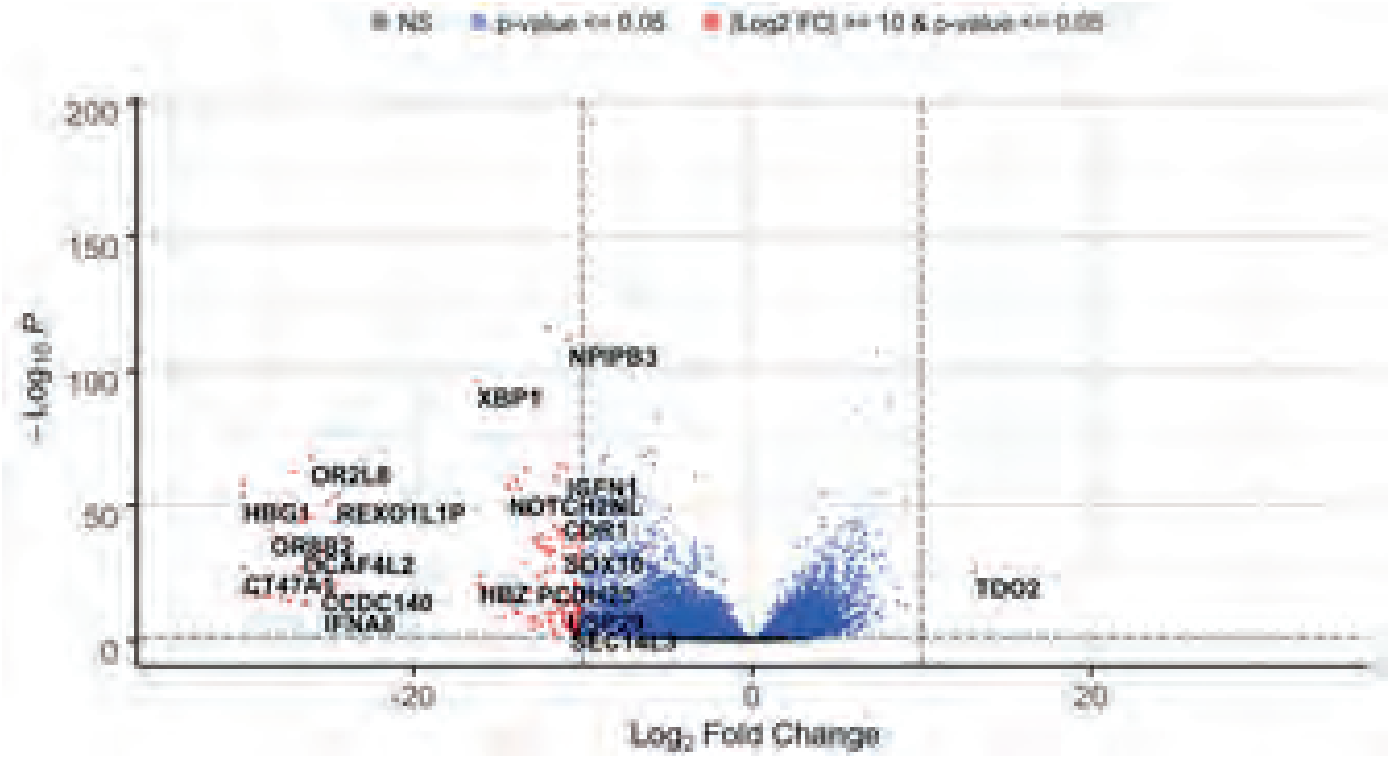



*Figure 1: Volcano plot of differential gene expression of high-grade*

TDO2 drives tumor progression by suppressing antitumor immune responses and increasing the malignant properties of cancer cells, including resistance to programmed cell death, cellular motility, and metastasis.12 These pro-neoplastic activities of TDO2 are exacerbated through its biochemical activity of controlling the catabolism of tryptophan to the tolerogenic kynurenine. This tryptophan-kynurenine pathway is exacerbated by stress hormones and/or by proinflammatory cytokines.13 Hence, populations of African ancestry that present with concurrent presence of high producer alleles of proinflammatory cytokines14 and hypothalamic-pituitary-adrenal

(HPA) axis genes15 are at high risk of upregulated tryptophan-kynurenine pathway, with concomitant psychoneurological effects. In addition, these factors contribute to maladaptive stress responses and associated with allostatic overload of individuals16. Hence, the tumor-associated upregulation of tryptophan-kynurenine pathway with concomitant systemic inflammation and chronic stress could impair the mental health and quality of life CaP survivors through allostatic overload.

Aside from urological and sexual problems, CaP survivorship experience is accompanied by poor mental health. 17 However, despite the high burden of CaP in Africa, poor survivorship experience and increasing mental health problems, there is limited data on the determinants of poor QoL among CaP survivors in Africa. Studies in Africa have reported increasing incidence of poor mental health among cancer survivors18-23, resulting in impaired quality of life, even in the face of improved therapeutic interventions for the underlying cancer24. Hence, understanding the biological etiology of cancer-associated decline in mental health and poor quality of life is imperative to increasing the survivorship experience and overall survivor of CaP patients, particular in Africa.

We therefore hypothesis that poor QoL is associated with mental health decline which is influenced by cumulative burden of chronic stress and cancer-induced alteration in tryptophan metabolism among Africans.

The cumulative effect of experiences in daily life of individuals, refers to as Allostatic load,25 is linked to cluster of poor mental health symptoms including fatigue, mood changes, cognitive and sleep disturbances, and pain, that collectively referred to Psychoneurological symptom cluster (PSC). Although PSC has been reported in cancers26,27, including CaP survivors28 and there are significant contributions of biology to its etiology, studies on PSC in Black CaP survivors have only focused on physical and psycho-social factors29. The adaptive biological pathways, which varied widely across human populations, such as inflammation, HPA axis, and the tryptophan/kynurenine system, could influence an individual's predisposition to PSC. Hence, quantifying these biological determinants provides the opportunity for identifying: (1) the contribution of ancestral genetic differences to CaP survivors' mental health, (2) the role of allostatic load in etiology of CaP outcome and survivorship experience and (3) putative targets for pharmacogenomics intervention.

The long-term goal of this research, working with Prof. Solomon Rotimi of Covenant University, is to understand the role of biology in the phenotypic heterogeneity of PSC among ethnically diverse Black CaP survivors. To account for the nativity and geography, our approach focuses on CaP survivors in Kenya (East Africa) and Nigeria (West Africa). This mirrors the bicoastal CaRE2 approach and will enable us to establish the within-group differences among Africans. This provides many advantages; including identifying: (1) the subpopulation at high risk of mental disorder, (2) group-specific biomarkers associated with specific PSC, and (3) putative targets for precision interventions to improve the quality of life (QoL) of Black CaP survivors. The specific objective of this study is to investigate the contribution of allostatic load to CaP survivors experience and establish its association with genetic variation of the HPA axis and upregulation of the tryptophan-kynurenine pathway.

## Completed Research Projects

- A90040, WHO/TDR. Protein-protein interactions of Trypanosoma brucei Splicing Factor SF3a60 as potential targets for novel trypanocidals
- AB/21623, International Foundation for Science. Functional characterization of trypanolysin at the tsetse-trypanosome interface.
- A50737, WHO/TDR. Pre-initiation complex assembly and dissociation in Trypanosoma brucei: Mapping of factors involved in stage specific regulation of gene expression, and in vivo analysis of gene expression.

## Publications

List of his published works can be accessed at
https://pubmed.ncbi.nlm.nih.gov/?term=nyambega+I

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## Gallery:




# 3. DR. LILIAN WANZARE (COMPUTER SCIENCE)

**Figure 1:** Investigators, from left Dr. Ayere, Dr. Wanzare, Dr. Okutoyi and Dr. Kang'ahi

**Profile:**

**Project Title:** **AI4KSL: Bridging Language Barrier using Artificial Intelligence for Kenyan Sign Language among Deaf Learners**

The AI4KSL project is led by a team of researchers from Maseno University and is co-hosted by the departments of Computer Science, Special Needs Education and Education Communication Technology & Curriculum Studies from Maseno University. The Principal Investigator is Dr. Lilian Wanzare, from the Department of Computer Science, and the co-investigators are Dr. Mildred Atieno Ayere and Dr. Maurine Kang'ahi from the Department of Education Communication Technology & Curriculum Studies, and Dr. Joel Okutoyi from the Department of Special Needs Education.

## Motivation and problem statement

Deaf learners experience language barriers as they cannot listen and express themselves using speech. In Kenya, deaf learners are supposed to be integrated in normal classrooms, however they continue to be taught in isolation because of the existing language barrier. Because of the limited number of sign language interpreters, these learners cannot be placed in integrated classrooms in Kenya. Learners are therefore left to automatically understand the teacher without an interpreter. This in turn compromises the quality of education among deaf and limits their access to education, thus excluding them. The key question for this research is therefore, how can assistive Artificial Intelligence (AI) technology be used in bridging language gap among deaf learners in Kenyan learning institutions?

The main objective of the project is to develop an assistive Artificial Intelligence technology for Kenyan Sign Language (AI4KSL) that translates spoken English to Kenyan Sign Language (KSL. Specifically, the project intends to build dataset for spoken English and video recorded Kenyan Sign Language, develop a prototype assistive AI technology from spoken and written text to KSL and finally evaluate of the assistive AI technology in the classroom with deaf learners during teaching and learning. The project hopes to foster inclusion and bridge the language barrier among deaf learners in Kenya.

## Methodology

The project is divided into 3 main phases in line with the objectives.
In the **first** phase, we will build the dataset of spoken English and video recorded sign language together with the transcriptions. We target to collect 5000 sentences and about 10000 video clips with English transcriptions. The project will collect data from various regions, different genders and levels of income to reduce the biases. To ensure gender equality, the project will be guided by the Kenyan constitution on gender-principle of engaging mixed gender, ensuring 30-50% representation of either gender at project engagements. To achieve this the project has partnered with six (6) schools for the deaf to work with during the data collection phase. These are St. Angela Mumias Secondary Vocational School For Deaf Girls, Ack Ematundu Boys Secondary/Vocational School For the deaf, Fr Ouderaa Secondary School For The Deaf Nyangoma, Maseno School For The Deaf Primary School, Ebukuya School For The Deaf Primary and Sikri Technical and Vocational College for the Blind and Deaf .

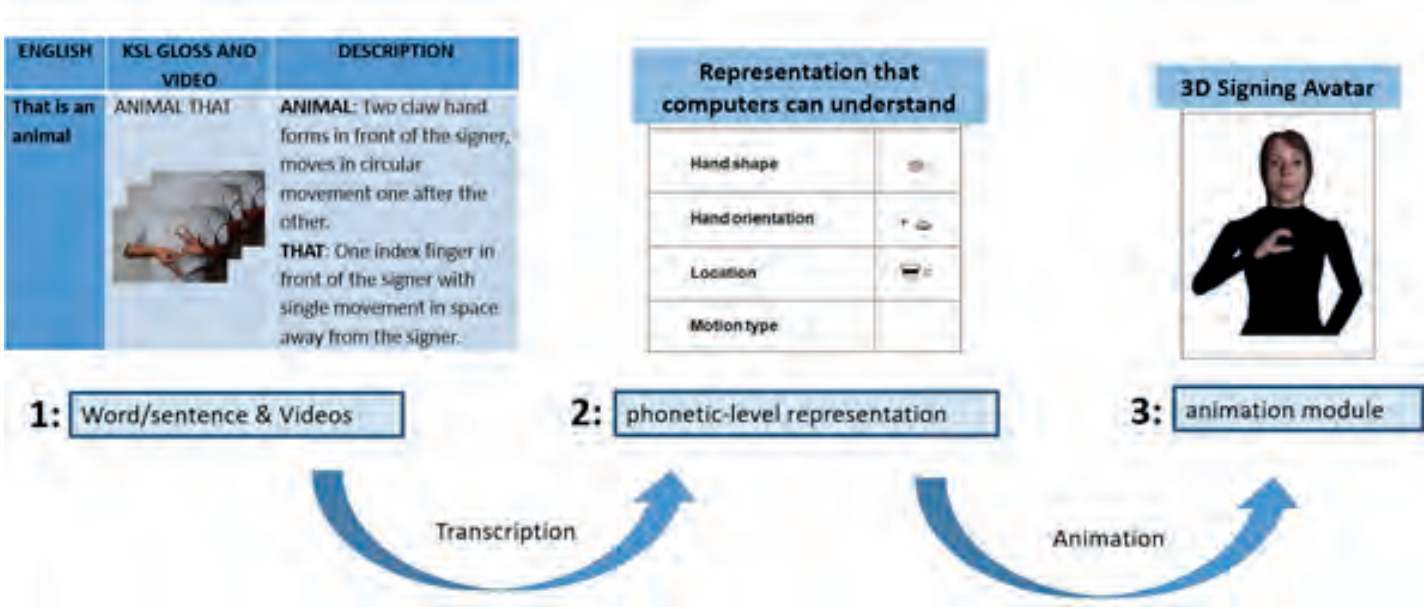


*Figure 1: AI4KSL Methodology*

In the **second** phase, we will build the assistive technology by developing a phonetic-level interface using the Hamburg Notation System for Sign Languages (HamNoSys) notation to capture KSL grammer followed by conversion of the HamNoSys transcriptions into Signing Gesture Markup Language (SiGML) XML based annotation language that will be input to the animation module. The animation module will generate signs and render them to the users.

*Figure 2: AI4KSL Inception and capacity building workshop 5th May 2023 with stakeholders from deaf community and schools for the deaf*

*Figure 2: Data collection at Ebukuya School for the deaf primary*

The **third** phase is evaluation that will involve verification of the AI technology. The project will perform verification of the phonetic notations against the KSL animation output using sign language experts. The project will also perform prototype testing in a classroom setup with deaf learners during teaching and learning. The objective will target special needs educators and deaf learners and train them on how to evaluate and provide feedback to improve on the assistive technology.

## Outputs, Outcomes and Impact:

The main outputs of the project will be the collated dataset containing videos of KSL, the corresponding spoken English and transcriptions that would be a basis for future research, the developed AI4KSL assistive technology, and report on the applicability of such an assistive technology in a classroom setup in under-resourced communities. The outcome of the project will be increased awareness of the need to use assistive technology to break barriers within the classroom and an understanding of the challenges of developing such assistive technology. As impacts, the AI4KSL innovation will break language barriers, increase learning outputs that lead to high quality education, increased transition, and completion rates among the deaf learners, improve bilingual proficiency; and improve engagement among stakeholders in Education on adoption of assistive technologies for learner engagement. The technology will be recommended for use in Kenya across learning institutions from Pre-Primary One (1) to universities among deaf learners. The technology will further provide a basis for development of similar technologies in Africa and worldwide in deaf education.

## Funders

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