THE HARMATTAN SCHOOL FOR MEDICAL PHYSICS: A THREE-YEAR REVIEW OF THE "CATCH THEM YOUNG" PROJECT

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Abstract— **The inaugural IPEM LMIC sponsorship award became a full-fledged partnership project between the Nigerian Association of Medical Physicists (NAMP) and the Institute of Physics and Engineering in Medicine (IPEM), and this gave birth to the annual medical physics harmattan school program for undergraduate physics students as a way to encourage more people to consider a career in medical physics and by effect increasing the number of qualified medical physics professionals in the country. The Covid-19 pandemic caused some modification especially with the lectures which were rendered virtually. In the maiden edition of 2021, a very far-reaching impact was already created as 99.4% of participants had increased knowledge of medical physics due to the harmattan school, 98.3 % were eager to participate in subsequent editions while all participants said they would recommend others to participate. After three editions, the number of participants increased by 12 %. While the harmattan school was specifically aimed at the undergraduates, more postgraduate students and even participants gainfully employed were increasingly becoming interested in the harmattan school. The female and foreign participants were also interesting features of the harmattan school which recorded significant increase. In fact, female participants in 2023 edition stood at 46 % while foreign participants rose to an unbelievable 38 %. The medical physics harmattan school proved to be an effective method of recruiting scientists into medical physics profession which is currently experiencing an acute shortage worldwide; it is also recommended for adoption in developing countries where none existed.**

Keywords— **NAMP, IPEM, Harmattan School, Medical Physics, Nigeria**

I. Introduction

Medical Physics can be simply defined as the application of physics in medicine. It is a branch of physics where theoretical and experimental methods and principles of physics are directly applied in medicine and health. This field came into more limelight when Wilhelm Roentgen in 1895 and Henry Becquerel's in 1896 discovered X-rays and radioactivity respectively. These discoveries actually accentuated the study of radiation medical physics; medical physics however has been a well-researched field of physics centuries ago. Physicists have a long time ago studied the physics of biological systems and possible medical application. Abbé Jean-Antoine Nollet (1700–1770) published his observations on the biological effects of electricity [1]. Later, Mauduyt de la Varenne (1732–1792) made critical study into the medical uses of electricity [2]. The inputs of physicists in medicine can never be overemphasized right from the beginning. Even in the heat of the French Revolution, Comte de Fourcroy (1755–1809), in 1791 launched a short-lived journal, La Médecine eclairée par les sciences physiques. In the introduction to the first issue, he lays out his own vision: "The study of medicine always starts with the study of physics. It is not possible to be a doctor without being a physicist." [3]

The first use of the term Medical Physics (or to put it more accurately, Physique médicale) was in Paris in 1778. The term was introduced by the general secretary of the Société royale de médecine, Félix Vicq d'Azir (1748–1794) [3] When Vicq d'Azir died shortly thereafter, he left a document that would, in due course, set Paris on the road to become the leading centre for medical training and research in Europe for the first half of the nineteenth century [4]. The document he left contained a plan, and this plan recommended that basic sciences, including medical physics, should be an essential part of medical training [5]. All these physicists led the way to the development of medical physics as we have it today, however we may credit the title of the founding father of medical physics to Jean-Noel Hallé, professor of medical physics and hygiene at the new École de santé (School of Health) in Paris (1754–1822) [6]. By 1814, a concise definition of medical physics in Nysten's medical dictionary was put forward.

Physics applied to the knowledge of the human body, to its preservation and to the cure of its illnesses. (Physique appliquée à la connaisance du corps humain, à son conservasion et à la guerison de ses maladie).[7]

Medical physics continues to make advances in many areas, and it will continue to expand since physics itself is all-encompassing. Medical physics courses cut across all the branches of physics, and it is safe to say that medical physics might be the only field where all the aspects of physics have an application. It is also fast becoming the most 'sort after' branch of physics. Pollard-Larkin, who earned her PhD in biomedical physics at UCLA, described her career as "the most rewarding thing I have engaged in." [8]

The Nigerian Association of Medical Physics (NAMP) was established in 1986 with a group of 4 members. To be a full member of NAMP, one must have obtained relevant

bachelor's degree in Physics or engineering and postgraduate degrees in Medical Physics; MSc/MPhil/PhD from accredited universities [9]. The number of medical physicists has since grown through the years to about 250 registered members practicing in the academia, industries and hospitals. This statistic may pass for a success story at first thought, but with a population of 200 million people, a steady progressive rise in cancer burden and a need of clinically qualified MPs, the story is a far cry from hope. According to Tspaki et al's estimation, approximately 58, 950 MPs would be required by 2035 [10] with a special focus on Africa and Latin American/Caribbean regions. Nigeria, the most populous of these regions thus requires a radical approach to increase its MP workforce. While medical physics in Nigeria grapples with a myriad of problems, the lack of recognition presently being faced by existing MPs in the clinic compared with other health professionals, makes matters worse.

Summer school, as we have come to know it, is a type of education that is usually undertaken during summer in which academic and non-academic instructions and activities are taken by students. Extended periods of summer have been shown to make students relapse academically in a phenomenon known as "summer slide" upon resuming school during fall [11,12]. Summer schools thus come in to fill this academic gap, and this is perhaps one of the major benefits of summer school while at the same time not overlooking the opportunity open to students to learn some skills make friends and be energized psychologically for a new academic calendar. In most parts of the world, summer school programs are offered as part of an educational curriculum of a school or as an open independent study program for a field of interest. 'Summer' programs can either target undergraduate students, postgraduate students or professionals to expose them to areas within field of interest that they may not know much about.

In 2021, NAMP with the support of IPEM organized its first ever 'summer' school program for undergraduate physics and engineering students. This was an initiative formed to increase the number of physics students taking up careers in medical physics by stirring up their minds which will by effect hopefully increase the number of qualified medical physicists in the country. The Federation of African Medical Physics Organizations (FAMPO) reported the alarming shortage of medical physicist (1,041 medical physicists for a population of 1.2 billion!) of in the region [13]. The dearth of qualified medical physicists is even on a higher scale. This calls for an urgent consideration in finding ways to reduce this shortage before it becomes a serious emergency. In the light of the problem cited above, the medical physics summer (harmattan) school thus aimed to create more awareness of the role of physics in medicine and increase the number of qualified Medical Physicists in the country by inspiring undergraduate physics students to consider the Medical Physics profession.

II. PRESENTATION NOTES

A. HOW IT STARTED

In 2019, IPEM through the then Vice President International, Prof Dan Clark OBE, launched an award in recognition of the challenges facing medical physicists and clinical engineers in Low- and Middle-Income Countries (LMIC). The award was aimed at supporting individuals in these countries, who showed potential as future healthcare leaders in the field of Physics and Engineering in Medicine and were able to demonstrate an enthusiasm and vision for developing professional activities in their local region. The main benefits of the award amongst others, included a 2-year sponsorship of IPEM membership, mentorship with a senior IPEM member, a certificate of recognition, 2 years support for development of professional activities and eligibility to apply for IPEM LMIC support grant. In January 2020, the first recipient of the award emerged, a member of NAMP. https://www.ipem.ac.uk/news/first-recipient-of-new-ipem-international-award-announced/

Medical physics in Nigeria needs renaissance, and the IPEM award presented an opportunity to make a worthwhile contribution. It was on this premise that the award would then be channeled towards relevant projects that would create, raise awareness and educate especially physics undergraduate students about medical physics.

B. THE ROAD TO THE HARMATTAN SCHOOL

A few project proposals for the development of medical physics in Nigeria were submitted to IPEM for consideration and approval. The first project that was approved was a medical physics school for creating awareness amongst undergraduate students. The aim of the school was also to expose participants to more areas of medical physics not practiced in the country, all with the intention of inspiring more physicists to consider a career in medical physics. The need for the school was stemmed from the challenge of the dearth of qualified medical physicists in the country. The proposal was approved, and it became a collaboration between IPEM and NAMP. In addition, NAMP were of the opinion that it was a very useful project for recruiting students for the postgraduate medical physics program and that it should run annually for 5 years. The school was planned to be held onsite in the 3rd quarter of 2020 in a location in the southwestern part of Nigeria. Unfortunately, the pandemic hit in the first quarter of the year. The first Covid-19 case in Nigeria was recorded on the 27th of February 2020. The country like the rest of the world, went into lockdown, and major activities were either stopped or restricted except for essential services like healthcare. This development caused the plans for the school to be suspended. Unfortunately, the severity of the pandemic continued and resulted in the continuous restriction of activities with large gatherings. The academic staff union of universities (ASUU) in Nigeria, about the same time were coincidentally on strike resulting in the

shutdown of universities. Undergraduate and postgraduate students were sent home. From all indications, this meant that the school could not be held onsite as planned. It was therefore postponed to the end of the year with the hope that the restrictions of the pandemic would have been lifted and the strike by ASUU called off. While waiting for the next steps, it was observed that the most part of the world were quickly adapting to the 'new normal' of virtual meetings and e-learning. This new awakening prompted a possibility of organising the harmattan school virtually. After accessing all the variables on ground, the decision to hold the first school online in the first quarter of the following year was upheld.

C. WHY HARMATTAN SCHOOL?

The organisers recognised that although this was the first time an event such as this would be held in the country in the field, the need to standout and be unique was necessary. Most similar schools are held in the 'summer', at a time when most students are on break. Nigeria does not have a summer season and it became worrying to name a school 'summer school' when it was planned to be held in a country where there was no summer and in a season that had a unique identity in West Africa.

Nigeria has three seasons: rainy, dry and harmattan; the interface between the rainy and dry seasons. The harmattan season is characterized by hot, dry and low humid weather. Since Nigeria located in the tropical region of Africa does not experience the summer weather, the name 'harmattan school' was adopted to reflect our peculiarity. It was therefore agreed that it would be called "The harmattan school for medical physics".

D. THE PROBLEM THE SCHOOL TRIED TO SOLVE

In 2018, the global perspective of the medical physics workforce was reported, the global shortage of medical physicists in comparison with global clinical needs was studied. This study revealed the looming 'pandemic' in the medical physics workforce especially in Africa and Latin America/Caribbean [10], and of course Nigeria stands out as one requiring a drastic measure to increase its medical physics workforce. compared to other countries. Obed et al. 2016 [14] and Ige et al.2019 [15] previously reported the state of the medical physics workforce in the country. One solution proffered in all three studies was the need to create more awareness of the applications of physics in medicine and the role physicists play in medicine. The intention of the harmattan school was then to lure the participants into considering careers in medical physics with the long-term goal of improving the healthcare system of the country and producing quality professionals in the field. It became imperative to target the younger generation if we are to make significant impact in the years to come.

This huge shortage of medical physicists continues to make headlines especially in low- and middle-income countries. Lancet Oncology reported that 22,000 additional medical physicists would be needed to cover radiotherapy needs in low- and middle-income countries by 2035, [16] and this figure represents only medical physicists needed in radiation oncology alone. Particularly worrisome is the meager 54 medical physicists [15] for a 200 million population in Nigeria. It is this shortage coupled with the need to properly equip medical physicists with the requisite skill and knowledge that the harmattan school made its mandate.

E. THE MEDICAL PHYSICS HARMATTAN SCHOOL MODEL

Summer school programs are not new to Science, Technology, Engineering and Mathematics (STEM) community. They were developed and organized for several reasons: to serve as a means of bringing people together to learn a subject, for the purpose of networking, and so on. They usually take the form of teaching, laboratory work, tours of facilities or a combination of all. Summer schools help build an educational system that is both globally competitive and epitomize higher academic standard [17]. Summer schools have been shown to improve thinking skills [18], help students advance their knowledge base of a particular subject area [19] and play an important role in closing the achievement gap [20] since research supports the fact that achievement gap widens even further for students categorized as low-income [21]; and since Nigeria is recognized as a low-income country, summer school will therefore profit a lot of students.

Summer school programs are held during summer period, and NAMP decided to organize its first ever 'summer' school program at that specific season of the year. The harmattan season is a season unique to western Africa occurring between the months of November and March; the harmattan school is thus scheduled during this period. Like most **'summer school'** programs, series of lectures covering relevant areas of medical physics were delivered over a few days with one day of virtual lab work. Although initially planned to be onsite, the onset of the Covid-19 pandemic and strict restrictions placed on large gatherings, altered the plans temporarily. In addition to the constraints caused by the Covid-19 pandemic, the country's higher institution lecturers were in a face-off with the government forcing the academic staff of universities (ASUU) to halt academic activities and by implication disrupting the academic calendars of government universities. This made it extremely difficult to decide on a period that would accommodate various applicants from different parts of the country. All these problems coupled with the Covid-19 pandemic led to the choice of virtual mode for the harmattan school. These challenges later became a blessing in disguise as the number and diversity of participants increased even as the pressure to get funds through sponsorships was greatly reduced due to the 'low cost' of virtual events. In addition to the lectures and to achieve the aim of improving the health care system in the long run, Do-it-yourself (DIY) projects were included to create hands on experience. The projects were carefully selected to initiate the interest of developing a mindset of fabricating

medical equipment and devices locally. The aim also was to present an atmosphere where various interests could be accommodated in the field of medical physics. Being the first time, this would be organized, a few challenges which were foreseen could arise were averted due to the virtual program. Challenges like sponsorship, interest in participation due to varying academic calendars of higher institutions in the country, cost of in-person attendance, travel security concerns for students travelling down from extreme geographical locations etc. This model was created to bring modern ideas from developed communities while allowing local facilitators interpret these ideas in a way that can be understood properly by the audience.

While there are a good number of summer programs for medical physics like the AAPM, GI-CORE, EUTEMP, etc., it is important to highlight clearly that the harmattan school does not exist to compete but aims to tailor the teachings to a local audience with the aim of raising a generation of medical physicists who have an agenda for national and regional development through research, clinical and industrial practices. This we believe is the way out of the crisis currently facing Africa and Nigeria's education and health systems development. It could also serve as a way of stemming the brain drain.

F. THE INITIAL FORMAT:

The initial format was to select qualified students from a pool of applicants. These students would then be treated to a series of lectures, seminars, projects, break out discussion/project groups under the supervision of coordinators from Nigeria. The projects were supplied by IPEM members to be co-supervised on ground by NAMP members. There were six projects altogether, one was from an AAPM member. The College of Medicine of the University of Lagos was the preferred choice of the harmattan school, and it was to be a 5-day event. While plans were underway, on the 30th of March, Nigeria like the rest of the world experienced a Covid-19 visitation and thus went into lockdown. Restrictions were placed on large gatherings and even inter-state travels. The Covid-19 debacle gave way to explosion of online learning, and this virtual mode of learning became a 'new normal' worldwide. It was at this point that the need to convert the harmattan school program to a revised (virtual) one became necessary.

The revised program would comprise a 2-day online workshop and 4 weeks projects. The workshop consists of talks and lectures from medical physicists and engineers' home and abroad in industry, hospitals and academia. The DIY projects at different campuses across the country would be under the supervision of lecturers (coordinators) in such schools with undergraduate physics student selected from various tertiary institutions in the country. The projects will run for 4 weeks; two days of online workshop and the remaining weeks for the execution of the projects. Day 1 would be for introduction, day 2 would be projects/ teams formation and explanation of projects and introduction of team to their coordinators. Selection criteria would be based on the merit of the application. Students would form groups in their schools after selecting a project by ballot or assignment. Toolkits would be sent to various participants. They would agree on a day to meet to discuss their ideas. A maximum of 120 students from various universities would make up teams of 3 in their schools/states. Nigeria has 36 states in the federation and the selection would take care of the geographical spread of the schools such that students would not need to travel too far from their schools. Each coordinating centre would structure the project such that the timetable of the participating students' school would be factored in.

III. THE NEED FOR ESCALATION OF INTEREST IN MP

Nigeria with a population of about 200 million has a medical physics strength of 54 [15]; this translates to one medical physicist to 3.7 million people. The United States has over 10871 medical physicists [22] for a population of about 330 million people. This represents a ratio of one medical physicist to about 30, 0000 people. Comparing Nigeria with the US, it is about 123 times more incapacitated in providing medical physics services to its population. Furthermore, as at the time of writing this paper, there are only 8 institution offering medical physics at post graduate level as reported by [15] despite having 220 universities accredited by the Nigerian Universities Commission [23] This number is even expected to drop should Nigeria have a medical physics education regulatory body like those in the US, UK, Canada and Australia.

It is also not surprising that medical physics unlike other aspects of physics like atmospheric physics, solid state physics and so on are not offered as options at undergraduate level; even where they are, the medical physics courses lack in content and coverage. So, most students do not have the opportunity of knowing about the application of physics in medicine. A few, though, through the Student Industrial Work Experience Scheme (SIWES) training programs, get to have clinical experience before graduation. A major problem facing medical physics profession is shortage of qualified staff as reported in many literatures [10, 24, 25, 26, 27] while scientific and professional challenges form another cluster of problem area in medical physics since it is a profession that is highly dependent on scientific ideas. In fact, in their study [28], they identified four grand challenges of medical physics in radiation oncology (the major area of medical physics): (1) improving target volume definition, (2) adoption of artificial intelligence and automation, (3) development of predictive models of biological effects for precision medicine, and (4) need for leadership. The harmattan school thus seeks to address the education and training deficiency faced by practicing medical physicists while at the same time raise appropriate awareness to physics undergraduates, and very importantly prepare medical physicists for leadership roles which has become an important aspect if we ever want medical physics to move beyond the

traditional role of just providing routine medical services. Leadership and mentorship are one of the key areas we need to fully explore and develop and move the medical physics profession from the status of always "explaining" it to "teaching" it. We need to prepare quality medical physicists who will build capacities in the profession and take the campaign outward because the recognition issue bedeviling medical physics in many countries as reported [29, 30] is directly related to the vague understanding of the role of medical physicists even among health professionals in radiation medicine safely attributed to no fault of theirs.

At this preliminary stage, the medical physics harmattan school attempts to raise awareness about medical physics in Nigeria with a view to getting more students to take up the medical physics profession that seriously needs a revamp. The harmattan school awareness was done through low budget publicity using social media. Google form was used as the application mode. Flyers were made and shared on the association's official website and social media platforms – WhatsApp, Instagram, twitter and Facebook. Figure 1 shows the e-flyers used for advertising the program in the three editions.

IV. The facilitators

In addition to the objectives of the school, one of the major things we wanted to showcase was the talents from Nigeria. There is this misconception people have generally about made in Nigeria and internationally imported items, the latter perceived as being of a better quality. This mindset has caused a slow growth in the empowerment of Nigerians generally speaking. The same mindset has found its way into our educational system. Taking the growing field of medical physics, where little is known amongst students, it is generally assumed that if you want a good medical physics education you have to look outside. That may have been true at the onset of the development of medical physics in Nigeria, but a lot has happened in the last decade. We decided that the harmattan school would be a good opportunity to create the balance and show young brilliant and passionate Nigerian medical physicists who were doing well in their endeavors. We hoped that it would also help to create a mindset of "I too can be like them" mentality. This of course did not overshadow one of the objectives of the school which was to also create awareness of the various applications of medical physics especially those which were not common in the country. This is where the facilitators from IPEM came in. They created the balance of bridging the gap between where we were as a country and where we hoped and ought to be. It is also important to note here that all facilitators both from NAMP and IPEM completely volunteered and were more than happy to be part of a program that was making a difference. In 2022 however we had two volunteers from the AAPM join the list of facilitators. The facilitators and the topics they taught are as presented in Table 1.

Table 1 Timetable for the 2021, 2022 and 2023 Harmattan School

Day	Topic	Facilitator
	2021	
1	Introduction to the Harmattan school	Iyobosa Uwadiae
	An Introduction to Physics in Healthcare	Liz Parvin
	An Introduction to Engineering in Healthcare	Dan Clark
2	Introduction to Health Physics	Tobi Ife-Adediran
	Radiation detection and measurement	Akin Omojola
	Physics of x-ray imaging	Maryann Ekpo
	Physics of nuclear medicine	Tolulope Ayodele
	Physics of molecular imaging	Tosin Ijaleye
	The physics of cancer treatment	Emmanuel Oyekunle
3	Application of cell mechanics in medicine	Kayode Dada
	An Introduction to Physiological Measurement	Dan Clark
	Physics of the eye	Chris Degg
	Physics of the ear	Chris Degg
	Physics of the heart	Leandro Pecchia
4	Application of Fourier transformation/ mathematical physics in medicine	Paul Morgan
	NMR in medicine	Michael Dada
	Sound waves in medicine/ultrasound	Bede Madu
	RF Interaction with the human body	Bright Aboyewa
	Artificial intelligence in medicine	Maruf Adewole
	Radiobiology and Artificial Intelligence.	Abayomi Opadele
5	Measurements of percentage depth dose and inverse square law	Dare Adewa /Temitope
	Calibration of MTS-N (LiF: Mg, Ti) chips with a RadPro TLDcube 400 manual reader	Orotoye Akintayo Omojola
	2022	
1	Medical Physics: the past, present and future	Lookman Abdallah
	Career prospects for Medical Physicists in Nigeria	Michael Akpochafor
	Career opportunities in Clinical Engineering	Dan Clark
2	Overview of Radiography and Medical Imaging	Jimmy Strinnger
	Understanding Digital Communication in Medicine	Peter Sandwall
	Patient dose monitoring and optimization in diagnostic radiology	Matt Dunn
	Radiotherapy Physics	Keith Langmack
3	MR Radio-Frequency Coils: Physics Principles and Design	Ben Stormont
	Pulse Oximetry Explained: Using Light Waves to Analyse Haemoglobin	Chenyang He
	Electricity in the Heart: The basic principles behind Electrocardiography	Busola Oronti
	2023	
1	Why I decided to study Medical Physics	Victor Ekpo
	Radiation around us	Francisca Abdul
	The History of Radiation Therapy	Evans Sasu
	Mammography: looking inside the breast	Akintayo Omojola
2	Biophysics: physics of life	Abba Lawal
	Machine Learning Applications	Michael Dada
	Cyclotrons: an introduction to particle accelerators in nuclear medicine	Adekunle Akintokun
	Electrical safety of medical devices and equipment	Busola Oronti

	DIY Projects	
3 months	Project 1 (Digital Communication in Medicine and Image Analysis) Projects 2,3,4,5 & 6	Completed Postponed due to the strike

Fig. 1 Harmattan School e-Posters (L-R): 2021, 2022 and 2023

V. The Applicants

A total of 455 applications were submitted to the harmattan school in 2021; 483 applications in 2022 and 542 applications in 2023. Applications were submitted via google and zoom registration forms. We expected all the applications to come from undergraduate students being the target audience, but many applications came from postgraduate students, medical physicists, and physicists in other fields. Even participants from outside the country took part in it. Table 2 summarizes the demographics.

Table 2 Demography of Applicants

Year	2021	2022	2023
No of Applications	455	483	542
Gender (Female)	29 %	26 %	46 %
Gender (Male)	71 %	74 %	54 %

Table 3 Spectrum of Applicants

Year	2021	2022	2023
No of Applications	455	483	542
Non-Nigerian Nationality	11.5 %	10%	38 %
Undergraduates	302	206	167
Graduates	78	98	85
Postgraduates	65	152	119
Working	10	27	168

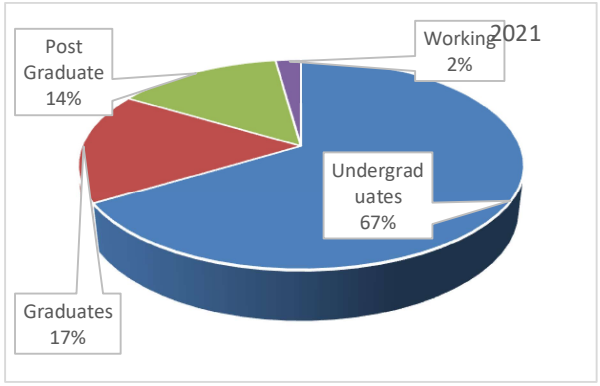

Fig. 2 Statistics of participants in 2021

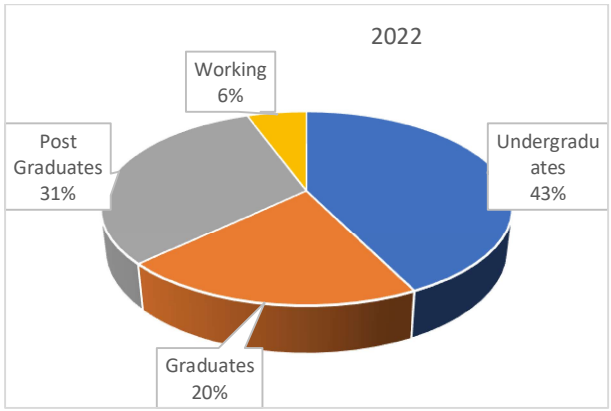

Fig. 3 Statistics of participants in 2022

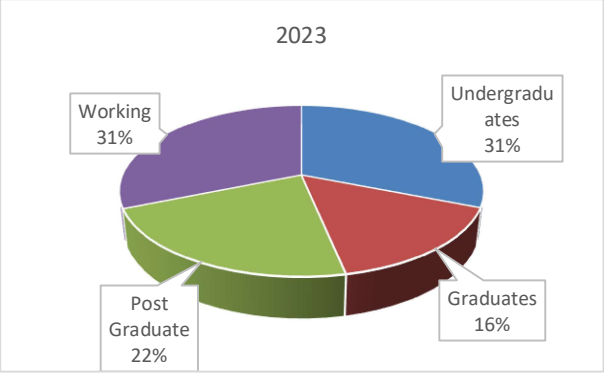

Fig. 4 Statistics of participants in 2023

In the maiden edition (2021), 80 % of participants had never heard of or participated in a similar program; 99.4% had an increased knowledge due to the harmattan school; 98.3 % asked to participate in subsequent editions; 100 % would recommend the school to colleagues and friends while 99.4 % said they would consider a career in MP. 0.4 % did not have access to a smart phone of personal computer. 84.6 % had access to a good internet connection while 15.2 % didn't. 93 % could dedicate at least 2 hrs. per day to attend the virtual school and 91.6 % showed interest in participating in the DIY projects. The others could not because they were either out of school or did not have access to a physics laboratory which was one of the criteria for participating in the projects.

VI. Analyses and Discussions

Although the school was primarily planned for undergraduate students, data collected during the school showed that students from other disciplines were equally curious about medical physics. As a matter of fact, postgraduate students and non-Nigerians participated in the school. Table 3 shows the distribution of the applicants across the spectrum.

More sponsorship would be sought to increase participation and develop an e-learning platform tailored to medical physics learning in Nigeria. 'tailored' because even though the world and field are advancing, we cannot shy away from the fact that the needs of continents, regions, race and even country still differ. The principle may be the same, but the application differs.

From the distribution (Tables 2 and 3) of the applicants and attendees of the program. The undergraduates that participated stood at 66.4% (302), 42.7% (206) and 30.8% (167) in 2021, 2022 and 2023 respectively. While the number of participants increased marginally in 2022 by 6% and hitting a double digit (12%) by 2023 with respect to 2022, the number of undergraduates however showed a downward trend. In fact, by 2023 the number of undergraduates almost halved. The reason might not be farfetched; in 2023 an 8-month strike was called off and students were much more imbued with resumption duties and subsequent examinations thereafter. This downward trend in undergraduate applications might be better seen as a positive impact of the harmattan school - Some students who were in their final years (who represent a good percentage of participants especially in 2021 edition) having enjoyed the first edition (2021) naturally joined the subsequent editions as postgraduates with a good number enrolled in postgraduate medical physics program, and as graduates undergoing the compulsory national service or working. Graduates include MSc student, PhD students and other at various levels of their careers. This points to the need for a similar program tailored for non- undergraduates so as not to lose the flavor of the harmattan school program for undergraduate students.

There might need to be other developed methods of sustaining the attraction that has been spurred by the harmattan school program. The harmattan school was an important strategy needed to lure undergraduate students into the MP profession and at the same time bridge the 'widening' knowledge gap.

Another interesting feature of the harmattan school is the participation of females. The percentage of women' participation in 2021 and 2022 were both about 30%, but in 2023 it peaked at 46% almost equaling the participation of men. This result is as interesting as it is encouraging because the percentage of women enrollment in physics and in fact in STEM programs have always been small. Even according to their study [10], the workforce of female medical physicists worldwide stood at 30%. So the significant increase in the number of female participants is an indication that more women are embracing medical physics.

An exciting upshot of the harmattan school was the participation of non-Nigerians. The school was designed for Nigerians since the original format was intended to be onsite which would involve huge finances to accommodate participants from outside Nigeria, however, the modification of the program into an online one (except some DIY projects) attracted interests from non-Nigerian participants. In the maiden edition about 11.5% foreigners participated. The percentage remained fairly unchanged to 10% in 2022 before an unprecedented 38% in 2023 signaling the growing interest in the medical physics field in other developing countries.

Table 4 summarizes the post-course survey of the 2021 harmattan school lectures; scores for each course of all participants were averaged. The lowest lecture score was 3.1, while the highest lecture score was 4.5. The overall average for all the lectures scored by the 174 respondents was 3. This represents a very good performance of the 2021 lectures.

VII. Feedback and Challenges

The first major challenge was the Covid-19 pandemic that halted the initial plans. This would then mean a waiting period of so many months. As the world moved forward

even with the pandemic, the harmattan school also had to adopt to the "new normal" of doing things. The online version was thus considered and eventually adopted with some peculiar problems. Some of these challenges were identified by the participants in a post-course survey shown in figure 5

The feedback/post course survey revealed another pressing need – the harmattan school provided an opportunity for 'loopholes' in the education of medical physicist in the country created by the lack or shortage of qualified clinical and academic medical physicists. Courses that were taught during the harmattan program were not only selected to introduce students to the field of medical physics generally, they were selected to introduce current trends and courses not commonly part of the medical physics academic curriculum in the country. This not only was beneficial to undergraduate students who had no idea of physics applications in medicine but even to post graduate students and working professionals. To increase involvement, it might be necessary to create similar programs tailored to PG students and practicing medical physicists.

Furthermore, the outcome of the survey informed the decision to reduce the number of days of the virtual school due to the challenges the participants faced. The ASUU strikes in 2021 and 2022 really affected the schedule as it scrambled the academic calendars of the universities except the privately owned ones. We also hoped to go back to the original plan of hosting the school onsite, but we couldn't do as planned. Three major reasons were the lack of funds, the irregularity in the academic calendars and insecurity. Nigeria is a very large country, and it would be difficult to gather students from the different geopolitical zones. To solve this problem, we planned that the school can be held in regions rather than all converging in Lagos or Ibadan. This will cost more but it will ensure that no one is left out.

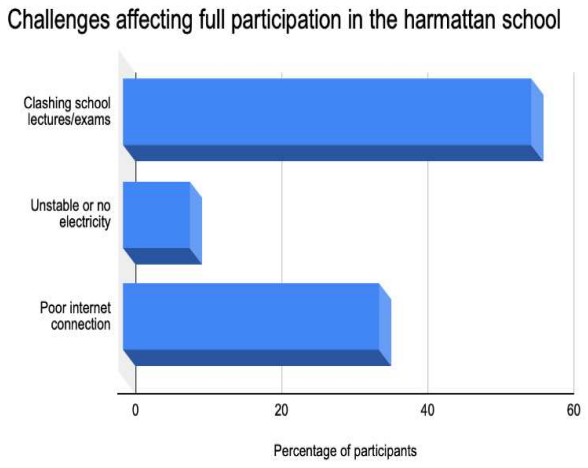

Fig. 5 Challenges affecting full participation in 2021 Harmattan School

Table 4. A post course survey in 2021 of 174 respondents

(A)QUESTIONS/RESPONSES IN PERCENTAGE	YES	NO	MAYBE
Have you participated in similar programs in the past?	20.1	79.9	-
Did you experience any challenge(s) during the program?	52.3	43.1	4.6
Did you know about medical physics before the program?	79.9	13.8	6.3
Did the school increase your knowledge of medical physics?	99.4	0.6	0
Would you like to participate in the harmattan school next year if given the opportunity?	98.3	0.6	1.1
Were you satisfied with the organization and technical aspects of the harmattan school?	94.3	5.7	-
Would you recommend the school to colleagues and friends?	100	-	-
(B) OVERALL SATISFACTION WITH THE LECTURES (22 Lectures)	Lowest Score	Highest Score	Average Score
The results are based on a scale of 1-5, where 1 represents the least score and 5 represents the highest score. The scores (lowest, average and highest) in the following columns have taken into account all the 22 lectures for the 174 respondents.	3.1	4.5	3.6

VIII. Conclusion

A. MATTERS ARISING

Nigeria like most other developing countries, is experiencing rapid brain drain in the sciences and medical profession. One way of preventing or slowing this down is by developing the system in a way that It becomes equally attractive or at least almost comparable. The harmattan school proved to be an effective way of equipping medical physicists with the requisite knowledge and skills, and thus become a major way to make up for some of the shortfalls during the ost graduate medical physics program. This will make medical physics more attractive to practice in Nigeria and stem the tide of brain drain.

The medical physics harmattan school never envisaged participants from outside Nigeria; it was a welcome surprise. This revelation can be leveraged upon to encourage other countries where medical physics summer school never existed, especially in LMIC countries to adopt the harmattan school model as a method to increase medical physics manpower, reduce the dearth of qualified medical physics which will ultimately lead to more proficiency.

B. EMBRACING THE OBVIOUS

Thanks to the COVID19 pandemic, the virtual/e-learning platform evolved quickly as a preferred teaching method for most of the developed world. It however still posed a challenge for a nation that had not previously embraced it due to several challenges highlighted in this paper. This learning method cannot replace the traditional face to face teaching experience, but it can be modified to create a blended method. They are challenges that need to be overcome if we are to develop the field of medical physics in the country to a reasonable comparable standard that could be serve as a landing strip (springboard) to solving local problems.

C. THE NEED FOR MORE COLLABORATION

The success, popularity and interest in the harmattan school program was partly spurred by the collaboration between NAMP and IPEM. The union was necessary to glean from both the experiences of the facilitators from both associations. The students needed to see their own and know that medical physics existed and was actively practiced in the country. A balance also needed to be created to fill in the technological gap that existed between the two regions represented.

The harmattan school program was a success and has been shown to be a potentially effective model or method of recruiting scientists into the Medical Physics profession. The collaboration between NAMP and IPEM contributed greatly to the success and effectiveness of the school and more collaborations between other medical physics organizations and related agencies are highly recommended to not only spice up the program but mitigate the knowledge and technology gap in the developing world.

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