



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)  
**Technical Innovations & Patient  
 Support in Radiation Oncology**

journal homepage: [www.sciencedirect.com/journal/technical-innovations-and-patient-support-in-radiation-oncology](https://www.sciencedirect.com/journal/technical-innovations-and-patient-support-in-radiation-oncology)



## Radiation therapist education and the changing landscape in Africa

K.A. Kyei<sup>a,\*</sup>, P. Engel-Hills<sup>b</sup>

<sup>a</sup> University of Ghana, School of Biomedical and Allied Health Sciences, Accra, Ghana

<sup>b</sup> Cape Peninsula University of Technology, Faculty of Health and Wellness Sciences, Cape Town, South Africa

### ARTICLE INFO

#### Keywords:

Clinical competence  
 Caring practice  
 Professional education  
 Radiotherapy radiographer  
 Activity system

### ABSTRACT

In the changing global landscape, education programs for radiation therapists (RTTs), also known as therapeutic radiographers or radiation therapy technologists, at higher education institutions (HEIs) are non-existent in many African countries. In countries with local RTT education programs, there is evidence of a wide variety of qualification types, including in-house training, diploma and degree offerings. However, what is consistent is the integrated curriculum approach to classroom theory and clinical work-based learning that across the continent follows the general structure of a work-integrated learning (WIL) approach, to enhance clinical competence and meet the needs of the health sector. This study used a qualitative approach with thematic analysis of publicly available documents and reflective writings followed by further analysis through application of the Cultural Historical Activity Theory (CHAT) to explore the changing landscape of oncology in Africa and the impact of this on the education of RTTs. The study was guided by the reflective research question: How can the systemic understanding of RTT training in a changing landscape enable competent and caring practice? The study extends prior research on RTT education in Africa and contributes to debates on the changing role of RTTs in a rapidly changing environment.

### Introduction: Radiation therapy practice

Radiation Therapy has undergone substantial technological advancements, yet the ever-increasing demands of the equipment and procedures for safe practice traverse alongside the continued need for patient care. In Africa, the changes in professional practice of the Radiation Therapist (RTT) have added layers of complexity because of the irregular transition to state-of-the-art treatments and the existence of a wide spectrum of challenging social circumstances amongst the population, patients and practitioners.

According to the International Agency for Research on Cancer (IARC) and the World Health Organization (WHO), the number of new cancer cases detected each year is expected to increase worldwide and especially in low-and middle-income countries [1]. Furthermore, it is expected that more than half of all cancer patients will require radiation treatment as part of their disease management [2]. Radiation therapy facilities require specialized infrastructure, and careful planning and treatment delivery by well trained personnel, to provide accurate treatment, appropriate radiation protection and optimized workflow [3]. The challenge in this changing landscape is whether Africa has the capacity to increase RTT training to embrace the growing demand of

patients that require radiation therapy [4]. Furthermore, there is the need for these professionals to be socially aware and prepared through relevant education programs for attentive practice [2]. The aim of this study was to systemically understand RTT education in a changing landscape to enable competent and caring practice.

### Methodology for exploring radiation therapy training

A qualitative, descriptive, and contextual design was adopted for the study on the impact of the changing landscape in oncology on RTT education in Africa towards enhancing competent and caring practice. The contextual data was synthesized from publicly available curriculum documents, published academic articles and technical reports. This was supported by reflections of the authors who have experience of the RTT education environment in a number of countries in Africa [5]. The descriptive component was applied to describe and gain a deeper understanding of the RTT Education system across the continent. Text data in the documents and reflections was manually coded using the reflexive thematic approach of Braun and Clarke [6] for the identification and interpretation of themes across the data sets. The analysis was guided by use of the elements of the activity system (Fig. 1), as incorporated into

\* Corresponding author.

E-mail address: [kakyei@ug.edu.gh](mailto:kakyei@ug.edu.gh) (K.A. Kyei).

<https://doi.org/10.1016/j.tipsro.2024.100263>

Received 7 March 2024; Received in revised form 12 July 2024; Accepted 19 July 2024

Available online 26 July 2024

2405-6324/© 2024 The Author(s). Published by Elsevier B.V. on behalf of European Society for Radiotherapy & Oncology. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Yrjö Engeström's [7] Activity Theory. Attention was given to exposing historical contradictions or conflicts to deepen the understanding of RTT education in a rapidly changing world, and to enable recommendations for improved competent and caring practice. This approach was considered appropriate for building knowledge on the topic in a complex and diverse environment.

*Theoretical Framework: Activity Theory*

Activity Theory is one of the practice-based approaches that is both a theoretical and methodological approach, well suited to educational environments where there is the study of work and learning [7]. This theoretical framework could therefore be applied as a systemic analysis of RTT education in and for Africa. The Cultural Historical Activity Theory (CHAT) lens allowed us to reveal and consider systemic contradictions within the RTT education system so as to uncover challenges and opportunities for transformation and development [7]. Fig. 1 briefly presents the elements of the activity system: Radiation Therapy Education in Africa. The subjects in the system are the RTTs in training and the object is the purpose of the education program which can be simplified to RTT education, including classroom theory and clinical training for competent and caring clinical practice. In the activity system the mediating artefacts support and enable the training while the community is all those involved in the activity to meet the object and purpose and who function within the rules of the program and environment, according to specified roles, shown as the division of labor.

The use of the activity system exposed important aspects of the changing landscape in oncology, radiation therapy and RTT training in Africa.

**Findings from the document review and reflections**

Thematic analysis of the curriculum documents and researcher reflections, broadly following the reflexive thematic approach of Braun and Clarke [6] revealed themes in this RTT education system that were aligned to available literature. These are presented as findings in the sections below.

*Varied entry level education of radiation therapists*

The current education programs for RTTs in Africa are varied and

have been limited to a few countries amongst those with available treatment centres. There are reports showing that radiation therapy for cancer treatment is available in 33 countries in Africa [8,9] and that there are currently eight countries known to have a continuous intake into RTT education programs (Table 1). These are Egypt, Ghana, Kenya, Morocco, South Africa, Tanzania, Uganda and Zimbabwe. This may not be a complete list, however it is known that many countries do not have RTT training and what is clearly demonstrated is the variation in RTT education programs on the continent. Also noted is that in some countries (e.g. Mauritius) there have been formalised education programs implemented for a single cohort of students as needed for the radiation therapy service in the country.

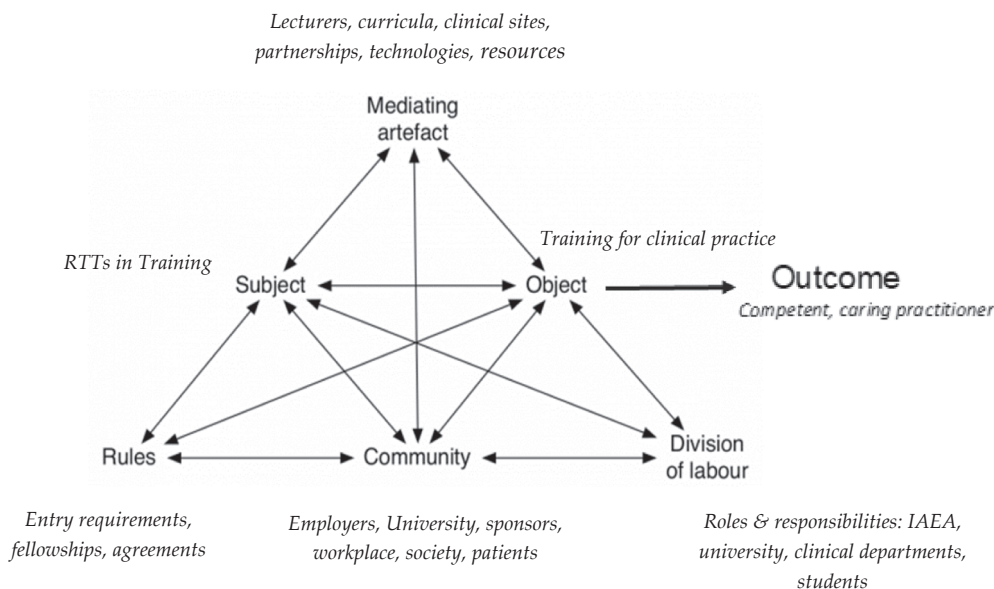
In Egypt and Morocco, training of RTTs is through a one year internship with in-house training, post a 4-year degree in diagnostic radiography [10].

In Ghana, there is currently one institution that educates for an entry level qualification for practice in radiation therapy as a 4-year full-time BSc degree. The HEI utilises one radiation therapy facility in the country for clinical training for students. Another HEI, which limits offerings to postgraduate qualification as an MSc and PhD in medical imaging and radiation protection, permits entry by RTTs for further studies with relevant research for the radiation therapy environment. This therefore is not for entry to practice as an RTT but is a suitable route for further advancement in the profession.

Kenya has two training institutions offering RTT programs. One of these is a university that offers a 4-year full time bachelor's degree for RTTs and the other is a college that offers a 2-year diploma. These two HEIs both utilize the seven radiation therapy facilities in the country for clinical training for the students.

In South Africa, there is training of RTTs at five HEIs. The university offering is a 4-year professional degree program [Bachelor of Science (BSc), Bachelor of Health Science (BHSc) or Bachelor of Radiography (BRad)]. It is noted that recognition of prior learning (1 or 2 years) is determined on an individual basis for those entering with a medical imaging (diagnostic radiography, nuclear medicine technology, ultrasonography) qualification. There is variation across the HEIs with regard to the postgraduate studies offered, however across the country opportunity exists for RTTs to enter Master and Professional Doctoral degree programs. South Africa has over 20 radiation therapy facilities for clinical training.

Tanzania has one clinical facility for RTT training. The HEI attached



**Fig. 1.** The RTT Training in Africa Activity System. .  
Source: Adapted from Engeström, [7]

**Table 1**  
Status of Entry Level Qualification for Radiation Therapist in Africa.

Country	Entry Level RTT Training	Number of HEIs	Years of Training	Classroom-based	Clinical placement	Taught By
Egypt	In-house training	Nil	1	No	Yes	In-house RTTs
Ghana	Undergraduate Degree	1	4	Yes	Yes	Faculty of University, clinical tutors and RTTs
Kenya	Undergraduate Diploma or Degree	2	2/4	Yes	Yes	Faculty of University, clinical tutors and RTTs
Morocco	In-house training	Nil	1	No	Yes	In-house RTTs
South Africa	Undergraduate Degree	5	4	Yes	Yes	Faculty of University, clinical tutors and RTTs
Tanzania	Undergraduate Degree	1	4	Yes	Yes	Faculty of University, clinical tutors and RTTs
Uganda	Undergraduate Diploma	1	2	No	Yes	In-house RTTs
Zimbabwe	Undergraduate Diploma or Degree	2	4	Yes	Yes	Faculty of University, Clinical Tutors and RTTs

to this radiation therapy department offers a 4-year BSc in Radiation Therapy. Uganda also has one radiation therapy centre offering a hospital-based undergraduate diploma for 2 years for RTTs.

Finally, Zimbabwe has two programs for RTTs. One is a university offering a 4-year BSc in radiation therapy and the other is a hospital-based 3-year diploma. It is noted that in Sudan a number of RTTs were qualified through the previously available program. This benefited the RTTs who had access to local training and furthermore provided several cohorts of well-qualified RTTs for the oncology service in this country. Due to the challenges of social disruptions and wars within the region, this program has been halted.

*Further education opportunities for radiation therapists*

Data shows that in some countries, RTTs can do further studies that include Master and Doctoral programs as well as postgraduate certificates/diplomas or in-house programs in radiation therapy, dosimetry, radiation protection, medical physics and health professions education. Of the countries that offer undergraduate programs, some (e.g. Ghana and South Africa) offer postgraduate opportunities for RTTs. A possible area for continuing education is a focus on patient care, also referred to as person-centred care, with an emphasis on support for patients of all ages and covering specific care needs for particular types of cancer [11]. RTTs can also move into management in radiation therapy or other radiography services, conduct on-treatment patient review and be involved more widely in oncology support services. Counselling of patients in oncology, with attention to on-treatment support, palliative and end of life care, is a direction chosen by RTTs in some countries such as, Kenya and Tanzania. Also important is the opportunity for RTTs to move into teaching and research positions through further studies. The education direction for RTTs can include becoming a practice educator, clinical research specialist or academic at a HEI. Finally, it is noted that RTTs can seek work opportunities in agencies or charities, covering issues such as quality assurance or patient care [12].

*Challenges to the education of RTTs in Africa*

The notion that in Africa, the education available for RTTs is inadequate is linked to challenges, such as staffing and funding at HEIs and that in most countries there are few radiation therapy facilities for clinical placements. Others have indicated that work-based training is resource-intensive and many hospitals in Africa are suffering from the South to North drain on existing staff capacity [13]. Further issues raised in the changing environment are the need for increased teaching capacity in the clinical sites. Some solutions offered by the rapid technological advancement are the potential for the use of simulation in education as well as the opportunity to improve the content of programs in the current educational system [14].

*Equipment Transition: A slow move from 2D to 3D*

In the lower-middle income countries (LMICs) in Africa, less than 50 % of patients needing radiation therapy have access to treatment, and the situation is worst in the low-income countries where only about 10 % of patients have access to treatment [15]. In the majority of countries there is evidence of the transition from the 2D to 3D (Table 2) although the move is slow for many. The reasons for a wide range of countries retaining Cobalt-60 vary but the high cost of Linear Accelerators is dominant. Frequent power failures, coupled with lack of on-site or even regional maintenance support for Linear Accelerators are other key findings. The strongest motivation provided for Cobalt-60 is that the

**Table 2**  
Equipment and System Capabilities.

Country	1D	2D	3DCRT	IMRT	VMAT	BRACHY
Algeria			x	x	x	x
Angola		x	x			x
Burkina Faso			x			
Botswana			x	x		
Cameroon			x			
Cote D'Ivoire			x			
Democratic Republic of Congo			x			
Egypt		x	x	x	x	x
Ethiopia			x			x
Gabon			x			
Ghana		x	x	x	x	x
Kenya	x	x	x	x		x
Libya	x	x	x			
Madagascar		x	x			x
Mauritania		x	x			x
Mauritius		x	x			x
Morocco			x	x		x
Mozambique			x			
Namibia	x	x	x			x
Niger			x			
Nigeria	x	x	x			
Reunion (France)			x			
Rwanda			x			
Senegal		x	x			
South Africa		x	x	x	x	x
Sudan		x				
Tanzania		x	x	x		x
Togo			x			
Tunisia			x	x		x
Uganda		x	x	x		
Zambia		x				x
Zimbabwe		x	x			

Division for Human Health, IAEA [3].

**Key to Abbreviations:** 1D: One Dimensional, 2D: Two Dimensional, 3DCRT: Three Dimensional Conformal Radiation Therapy, IMRT: Intensity Modulated Radiation Therapy, VMAT: Volumetric Modulated Arc Therapy, BRACHY: Brachytherapy.

equipment is specifically designed to provide state-of-the-art treatment in low resource settings and to significantly increase the number of patients that can be treated, as well as improve the overall quality of care. On the downside is that some of the equipment is old and unable to accommodate modern treatment techniques, thus entrenching 2D treatment. Also, there is some evidence of the Cobalt sources not being changed frequently enough to maintain suitable treatment times. A typical case was a particular period in Ghana, where for both Cobalt machines in the two big cities, the change of sources was delayed for 2 years leading to long treatment times because of the low output from the decayed sources.

#### *Late presentation a reality for many*

Late presentation is one of the greatest peculiarities of cancer patients in the African context where this reality still exists [16,17]. Reasons include dismissal of the seriousness of the disease, the urban location of most of the hospitals making them distant and difficult to access for most of the population, and patients resorting first to alternative medicine such as traditional and faith healers [17,18]. In all regions of Africa, advanced stage disease is still a burden and the need to find clear interventions and pathways to address late presentation is paramount. This situation impacts on RTT training and a focus on the importance of learning about palliative care was found in the data. Evidence of education for curative treatments and advanced technology, was also found in all programs, even where the available equipment did not necessarily allow for the most recent techniques used in modern radiation therapy. This means that some theoretical learning is unable to be experienced in the clinical training environment.

#### *Access to radiation therapy*

The radiation therapy deficit across the African continent, with many patients still not having access to treatment, continues to be a challenging issue. There is a significant and growing cancer burden, however the availability of radiation therapy in Africa remains limited (Table 2). Furthermore, even in countries with radiation therapy, there is evidence of infrastructural challenges such as lack of equipment maintenance, inadequate local technical support and frequent machine breakdowns [19]. The education of RTTs in this unequal environment demonstrated evidence of resourcefulness and novel approaches to preparing for competent and caring practice in the well and poorly resourced clinical settings found across the continent.

#### **A focus on the RTT education system**

The RTT Education Activity System and recognized ‘contradictions’ within this system, were the focus of the further analysis using CHAT. An understanding of training challenges, as well as possible solutions, were developed through this analysis, underpinned by the thematic analysis and relevant literature.

#### *Understanding RTT education in Africa as an activity system*

In the activity system of RTT education in Africa (Fig. 1), the subject, RTTs in training in Africa, leads to the object and it is apparent that the current, varied programs for RTT training are considered to be effective for preparing students for clinical practice in the local settings [20]. An additional object is found in that the degree programs also prepare students for practice beyond the local environment and for further studies. This is evidenced by the steadily increasing number of RTTs (5) applying for Master and Doctoral programs in countries including Ghana and South Africa. Analysis of the RTT training system shows clearly that with the roll out of additional treatment facilities on the continent there are insufficient training centres in Africa to meet the expanding need for RTTs. According to World Health Organization (WHO), the number of

new cases of cancer is expected to rise from 14 million in 2012 to 22 million by 2030. This will drive the growth of radiation therapy and create a huge demand for personnel though primarily for RTTs [19].

The mediating artefacts demonstrate a wide variation of resources, qualification levels and curriculum approaches amongst the HEIs and clinical training sites, both within and across countries. However, key curriculum elements were found and for many programs this was influenced by the core curriculum for RTT training provided by the IAEA [21]. In all countries a partnership exists between the HEIs and the clinical facilities to facilitate theoretical and work-based learning through an integrated curriculum.

The pathway of RTT education in Africa is variable and in many countries, there are to-date no undergraduate and/or postgraduate programs to provide for the continuous development of competent and caring RTTs for the expanding needs [10]. A recommended pathway (Table 3) that is already available to RTTs in some countries, is described as a correlation of Activity Theory elements and the purpose of the education. This makes a contribution towards understanding key historic perspectives [8], and gives recognition to the current status and challenges of RTT education in Africa. Furthermore, possible recommendations are exposed for a more consistent application of this pathway across all countries or regions in Africa.

#### *Contradictions in the activity systems*

Engeström [7] explains contradictions as being the motivating force or engine that drives change in an activity system. The alignment between elements of the RTT education activity system and the education pathway recommended for RTTs may seem to balance (Table 3) but inevitably there are contradictions, and these often arise from historical origins.

#### *Object and mediating resources*

The researcher reflections indicate that the historic reality of RTT education in Africa is that programs are introduced in a country once a radiation therapy service has been established. This can be soon after introduction of the service or some time may pass during which RTTs are trained externally or through experiential in-house training. This gives rise to challenges as in new departments the available resources often contradict the intended object of training for RTTs. The increasing demand for education programs would best be served by establishing local or regional training centres, but the resources work against this as a favoured option and often external training, beyond the region, continues long after the time when a country could establish a local program. To avoid an impossible demand on the RTT education system in Africa as a whole, countries should be supported to overcome the challenges (e.g. contradiction: object and mediating artifacts) and implement local programs as soon as possible. Particularly now, in the time of a high-volume loss of expertise to the global North, the contradiction between mediating resources, object and outcome are evident, even in countries with well-established programs. They can be supported to continue training for other countries but ultimately the solution remains that more local and regional training centres should be initiated. In striving for the expansion of RTT education in Africa with some consistency across the continent, the advances in technology provide the potential for more collaborative mechanisms whereby students in one country could benefit from teachers in another country and simulated learning where equipment is not available in the local environment.

#### *Object and rules*

Another contradiction that became evident is one between rules and the object. In Africa, the object of training RTTs is in itself a contradiction as there is inconsistency in the programs offered across the continent. Some training was found to be through work experience, other countries offer diploma level programs and yet others are in line

**Table 3**  
A pathway for training RTTs in Africa.

	Higher Education Institution ( <i>significant variation</i> )	Work-based Learning: Competence	Work-based Learning: Caring	Continuing Professional Development (CPD) ( <i>greatest variation from non-existent to PhD</i> )
<i>Object</i>	Theory Learning	Learning clinical practice	Gaining social awareness and caring attitude and skills	Changing practice; Role extension, management, education, further studies
<i>Subject</i>	Full-time students	Students on rotations or fixed placement	Students on rotations or fixed placement	RTTs in postgraduate programs, short fellowships, workshops, seminars, industry offerings etc.
<i>Mediational Artifacts</i>	All the mediating means of the HEI	Supervised practice with all available infrastructure in the clinical sites	Supervised practice with exposure to authentic clinical environment and patients	All mediating means of Formal and Informal opportunities for CPD
<i>Division of Labor</i>	Student: learn Academic: teach, assess	Student: work, practice, active participation RTT/clinical tutor: mentor & assess Academic: prepare, teach & assess	Student: engaged practice RTT: mentor Academic: prepare, support & teach	Varies with activity but main responsibilities are shared by the RTT doing the CPD and those offering the activity
<i>Community</i>	All involved at HEI	All in Clinical facility/ies & HEI	Clinical facility, HEI, patients, multi-professional team	RTTs, all those who offer program, others dependent on CPD activity
<i>Rules</i>	HEI rules, regulations, policies & procedures	Health sector policies, rules & procedures HEI rules	Health sector procedures plus social values HEI rules	Rules and policies linked to CPD generally & to specific activities
<i>(Intended) Outcome</i>	Foundational and professional knowledge for entry level practice	Professional competence	Social awareness & caring practice	Specific to CPD activity e.g. advanced practice in dosimetry, training on new equipment, expanded knowledge etc.

with international standards of undergraduate training through a 4-year professional degree. The challenges that emerge in the contradictions between the rules and object are therefore complex. They relate to how RTTs are perceived within the health sector and oncology, more specifically, the role distribution (division of labour) of team members and the higher education rules of the countries. This can make establishing a coherent network of equivalent programs across Africa seem like an impossible dream, and yet that is a goal worth striving for. Regional and international guidelines on minimum standards for RTT training are helpful to promote rules for appropriate education programs [22].

#### Implications for the education of RTTs

Two contradictions in the activity system were used to expose challenges in the system, raised through exploration of the changing landscape, and to offer possible ways to improve the offering of RTT training in Africa. These contradictions and the analysis of the elements of the activity system provide for an improved systemic understanding of RTT education in Africa.

The activity analysis raised the lack of resources, human and infrastructure, as a serious constraining factor for the implementation of sustainable RTT programs. There are examples of countries where programs cannot be offered because of the lack of suitable clinical sites yet in the contradictory cycle the implementation or upgrade of clinical sites, means that qualified RTTs are essential. This challenge becomes impossible to manage without the opportunity for external training for at least a first cohort of RTTs, however that in turn can place pressures on the already stretched external providers. Also confirmed through this research is the importance of the academic and clinical site collaboration. This partnership remains an essential mediating resource for training of RTTs as it ensures adequate knowledge, competence and caring; the intended multi-focused outcome of the activity system.

#### Conclusion

In the rapidly changing landscape of radiation therapy there is the need for continuous scrutiny of education programs so that suitable subjects (students) enter the system directed towards the object (purpose of the RTT education program). The deliberations and changes must be guided by the radiation therapy/oncology team (community) and then within the rules (international, national and institutional), and supported by the mediating factors, the students learn their role

according to the division of labour in the environment and are able to achieve the outcome of competence and caring.

The concerns that persist in RTT services in Africa place a heavy responsibility on HEIs and health professions educators. Hence, understanding these dynamics as a system, can lead to better alignment between the service and education needs for RTTs in Africa. A key understanding gained through the study is that the RTT education system in Africa would benefit from a collective regional approach. By drawing on the strengths of those HEIs and clinical sites with existing education programs in place, including those with undergraduate, postgraduate and further specialist programs, regional collaborations could provide mediating tools and communities of practice to support the development of training in many more countries.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Acknowledgements

We acknowledge all member states who contributed any information to this paper and the IAEA for the vast documents on Radiotherapy in Africa. We acknowledge the IAEA for the support throughout the study

#### References

- [1] Division for Human Health: DIRAC (Directory of Radiotherapy Centres) (iaea.org).
- [2] Bishr MK, Zaghoul MS. Radiation therapy availability in Africa and Latin America: two models of low and middle income countries. *Int J Radiat Oncol Biol Phys* 2018; 102(3).
- [3] Levin CV, El Gueddari B, Meghzi A. Radiation therapy in Africa: distribution and equipment. *Radiother Oncol* 1999;52(1):79–83.
- [4] Burner T, Svendsen B. Activity Theory Lev Vygotsky, Aleksei Leont'ev, Yrjö Engeström. *Science Education in Theory and Practice: An Introductory Guide to Learning Theory*. 2020:311–22.
- [5] Hansen, A., Engel-Hills, P., Jacobs, C., Blitz, J., Cooke, R., Hess, L., Leisegang, K., Naidoo, N., Volschenk, M. & van Schalkwyk, S. (2023). Understandings and practices: Towards socially responsive curricula for the health professions. *Adv in Health Sci Educ* (Published Online 2 February 2023). <https://doi.org/10.1007/s10459-023-10207-0>.
- [6] Braun V, Clarke V. Conceptual and design thinking for thematic analysis. *Qual Psychol* 2022;9(1):3.
- [7] Engeström Y. Expansive learning at work: Toward an activity theoretical reconceptualization. *J Educ Work* 2001;14(1):133–56.

- [8] Elmore SN, Polo A, Bourque JM, Pynda Y, van der Merwe D, Grover S, et al. Radiotherapy resources in Africa: an International Atomic Energy Agency update and analysis of projected needs. *Lancet Oncol* 2021;22(9):e391–9.
- [9] Barton MB, Frommer M, Shafiq J. Role of radiotherapy in cancer control in low-income and middle-income countries. *Lancet Oncol* 2006;7(7):584–95.
- [10] Ige T, Lewis P, Shelley C, Pistenmaa D, Coleman CN, Aggarwal A, et al. Understanding the challenges of delivering radiotherapy in low-and middle-income countries in Africa. *J Cancer Policy* 2023;1(35):100372.
- [11] McFadden S, Neil AO, Flood MT, Guille MS, Oliveira MC, Barbosa MB, et al. Person centred Care in the Radiography curriculum—the patient’s perception of undergoing Radiotherapy. *J Med Imaging Radiat Sci* 2022;53(4):S27.
- [12] Logan BI. The reverse and return transfer of technology (RRTT): Towards a comprehensive model of the migration of African experts. *Int Migr* 2009;47(4): 93–127.
- [13] Engel-Hills PC. Professional expertise for radiation therapists in Africa. *J Radiother Pract* 2007;6(3):125–31.
- [14] Burger H, Wyrley-Birch B, Joubert N, Trauernicht CJ, Valentim JM, Groll J, et al. Bridging the radiotherapy education gap in Africa: lessons learnt from the Cape town access to care training programme over the past 5 years (2015–2019). *J Cancer Educ* 2022;37(6):1662–8.
- [15] Abdel-Wahab M, Bourque JM, Pynda Y, Izewska J, Van der Merwe D, Zubizarreta E, et al. Status of radiotherapy resources in Africa: an International Atomic Energy Agency analysis. *Lancet Oncol* 2013;14(4):e168–75.
- [16] Velarde A, Najera KD, Gay HA, Powderly WG, Mutic S, Green J, et al. Transitioning from Old Cobalt-60 Teletherapy to Modern Linac Radiotherapy in a Lower-Middle Income Country Guatemala. *Int J Radiat Oncol Biol Phys* 2020;108(3):e430–1.
- [17] Donkor A, Lathlean J, Wiafe S, Vanderpuye V, Fenlon D, Yarney J, et al. Factors contributing to late presentation of breast cancer in Africa: a systematic literature review. *Archiv Med* 2015.
- [18] Cross C, Mokua S, Ngilangwa R, Santos C, Ngoma T, Mujinja PG, et al. 11. Cham: Springer International Publishing; 2024 Jan. p. 93–111.
- [19] Abdel-Wahab M, Gondhowiardjo SS, Rosa AA, Lievens Y, El-Haj N, Polo Rubio JA, et al. Global radiotherapy: current status and future directions—white paper. *JCO global oncology* 2021 Jun;7:827–42.
- [20] Engel-hills pe.. Radiation therapists in Africa: a journey of identity. Paradigms 2016.
- [21] Series tc.. A handbook for the education of radiation therapists (RTTs). Vienna: IAEA; 2014.
- [22] Mgbakor AC, Ogbonna AO, Oranusi KC, Azike JE. Cancer Management in Africa: The Burden of Late Presentation and the Case for Cancer Awareness. *Int J Pharm Med Sci* 2014;4:10–6.