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Building the capacity to solve complex health challenges in sub-Saharan Africa: CARTA's multidisciplinary PhD training

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ABSTRACT

OBJECTIVES: To develop a curriculum (Joint Advanced Seminars [JASs]) that produced PhD fellows who understood that health is an outcome of multiple determinants within complex environments and that approaches from a range of disciplines is required to address health and development within the Consortium for Advanced Research Training in Africa (CARTA). We sought to attract PhD fellows, supervisors and teaching faculty from a range of disciplines into the program.

METHODS: Multidisciplinary teams developed the JAS curriculum. CARTA PhD fellowships were open to academics in consortium member institutions, irrespective of primary discipline, interested in doing a PhD in public and population health. Supervisors and JAS faculty were recruited from CARTA institutions. We use routine JAS evaluation data (closed and open-ended questions) collected from PhD fellows at every JAS, a survey of one CARTA cohort, and an external evaluation of CARTA to assess the impact of the JAS curriculum on learning.

RESULTS: We describe our pedagogic approach, arguing its centrality to an appreciation of multiple disciplines, and illustrate how it promotes working in multidisciplinary ways. CARTA has attracted PhD fellows, supervisors and JAS teaching faculty from across a range of disciplines. Evaluations indicate PhD fellows have a greater appreciation of how disciplines other than their own are important to understanding health and its determinants and an appreciation and capacity to employ mixed methods research.

CONCLUSIONS: In the short term, we have been effective in promoting an understanding of multidisciplinary, resulting in fellows using methods from beyond their discipline of origin. This curriculum has international application.

KEY WORDS: Capacity building; research; developing countries; Africa South of the Sahara; multidisciplinary

La traduction du résumé se trouve à la fin de l'article.

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In the complex world we live in, social, physical, historical, and other contextual factors impact on both the distribution and prevalence of disease and on the effectiveness of interventions to prevent or reduce disease.^{1–3} It follows that challenges in public health require a multidisciplinary approach.⁴

Effective public health researchers need to be literate in other research approaches and methods in addition to having a thorough grounding in their own discipline. They should understand that there are alternative ways of generating knowledge, and should have an appreciation of the theoretical basis to different research methods and the importance of matching methods to specific research goals. This requires familiarity with the philosophy of science (ontology and epistemology) and facilitates interdisciplinary and transdisciplinary research approaches.

Various multi-, inter- and transdisciplinary programs have been developed with the aim of enabling scholars to engage in collaborative research.^{5–7} Here we describe the development, delivery and process evaluation of the Consortium for Advanced Research Training in Africa (CARTA), which aims to develop a critical mass of effective researchers in public health in sub-Saharan Africa. One impetus for developing CARTA, consequent on the scarcity of African-led research, is the demand for researchers

with cross-disciplinary competencies capable of heading multidisciplinary research teams.⁸ In CARTA, we emphasize the value of research approaches that draw on multiple disciplines. Our goal is to provide PhD candidates with the knowledge to appreciate and understand the complexity of addressing public and population health issues, the skills to work with people from a range of disciplines, and the capacity to critically assess research across disciplines. For convenience, we use the term “multidisciplinary” to describe our training, but we acknowledge that there are significant and important debates about what constitutes trans/multi/cross/omni-disciplinary approaches and the relative values of each.^{9–11}

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The Consortium for Advanced Research Training in Africa

CARTA accepts a cohort of new PhD students each year, who then receive structured, supplementary training over a three-year period. The consortium brings together nine African universities, four African research centres, and a number of northern partners, including universities and a Canadian network of public health researchers.⁸ CARTA first accepted PhD fellows in 2011; to date, seven cohorts ranging from 20 to 27 candidates have been admitted (165 in total). CARTA fellowships are competitive and based on merit. The fellowships are open to academic staff at all the African partner institutions who want to pursue a PhD related to public and population health. There are no disciplinary limitations; anyone may apply, providing that they meet the CARTA entry requirements. Successful candidates register at any one of the CARTA African universities, and follow the rules of that institution with regard to entry criteria and disciplinary requirements. PhD candidates are referred to as “fellows”, acknowledging that they are colleagues. We believe this terminology communicates a particular set of values, including mutual respect. The training provided by CARTA, and described in this paper, supplements the university-based PhD training, which is almost always discipline-specific.

Pedagogical approaches and content of the Joint Advanced Seminars (JASs)

The Joint Advanced Seminars are a key part of the fellows’ curriculum. Each involves a residential course lasting four weeks. Four JASs are provided at critical points during the fellows’ PhD candidature (see Table 1) with content and at intervals to promote quality research protocol development, timely completion, and critical self-reflection. Detailed learning outcomes are described elsewhere.⁸ These seminars promote sharing of tacit knowledge and a supportive network of researchers both within and between cohorts. The residential seminars are complemented by “inter-JAS” deliverables (Table 1), which must be completed before fellows are allowed to attend the next seminar. Fellows are supported by a web-based discussion group.

In this article, we focus on the elements that promote one of CARTA’s major aims: to develop an appreciation of and capacity for multidisciplinary research. We aimed to achieve a balance between the different epistemologies, methods and subject areas we felt to be essential.

We also expose fellows to many different ways of teaching. Didactic teaching is often the norm in many sub-Saharan African universities with inadequate funding of higher education, and massification of undergraduate education, leading to large class sizes.¹² By contrast, we employ participatory and experiential learning.¹³ Teaching sessions are informal, invite critique and robust discussion, and challenge hierarchy. We encourage a junior lecturer to debate a professor, promoting the exchange of perspectives consistent with multidisciplinary doctoral training.¹⁴ Value is measured by the coherence of an argument or the robustness of evidence, not on the status of the person making the point. This encourages fellows to use evidence and theory to defend their argument and reinforces that there is no hierarchy between disciplines.

We emphasize the triangulation of data and the ability to draw on multiple theoretical frameworks to build a holistic understanding of public and population health.¹⁵ Our approach is anti-hierarchical, participatory and relational,¹⁶ consistent with the concept of the citizen scholar.¹⁷ In Boxes 1–3, we provide examples of the alternative learning spaces that allow participants to engage in multidisciplinary action with others and with the text and tools of a number of disciplines.¹⁵ Our approach to teaching also allows us to illustrate multidisciplinary in action; for example, the session described in Box 2 was co-facilitated by an epidemiologist and an anthropologist.

Each residential seminar is led by a team of facilitators – a descriptor intended to emphasize our pedagogic approach, where learning is a function of interaction among adults rather than the outcome of hierarchy. Facilitators are drawn from staff across all CARTA consortium members, south and north, and where appropriate from elsewhere, for example, journal editors. In addition to training PhD fellows, we run workshops with their PhD supervisors in parallel with the second residential seminar, where the CARTA approach and philosophy is expounded for supervisors. This is to mitigate the possible disconnect between supervisors’ approach to PhD training and CARTA’s multidisciplinary approach. It also provides time for fellows and supervisors to interact in a collegial manner, including organized social interactions.

Evaluation methods

To evaluate the impact of the residential seminars, we have drawn on data routinely collected during the delivery and review of the

Table 1. Timing and major focus of Joint Advanced Seminars and “inter-JAS” activity

Timing	Activity	Major focus of the JAS
Month 1	JAS1 Inter-JAS	Understand the social determinants of health and the relationship of this to multidisciplinary research; build critical thinking; develop capacity to define and critique a PhD research question; develop specific research competencies (searching the literature, academic integrity, referencing, knowledge synthesis, etc.). Intensive online writing support provided by ESE-O (see www.eso.ci). Complete an inter-JAS teaching assignment (fellows choose any aspect of the JAS1 curriculum they believe would benefit students at their home institution) including student evaluation thereof.
Month 7	JAS2 Data collection and inter-JAS	Introduction to qualitative and quantitative research methods; finalization of individual research protocol; develop an approach to data analysis. Twenty months during which fellows collect the data for their theses. Complete an inter-JAS teaching assignment (fellows choose any aspect of the JAS2 curriculum they believe would benefit students at their home institution), including peer evaluation thereof.
Month 27	JAS3	Fellows can only attend this JAS when they have collected most of their data. Focus on analysis, interpretation, write-up and presentation of data.
Month 33	JAS4	Personal and professional development, academic leadership and life as a researcher and academic after graduation.

Box 1. Appreciating evidence from a range of disciplines – A pedagogic approach used in JAS1

The aim of this exercise is to:

1. Introduce fellows to the epistemology of a variety of disciplines
2. Collate knowledge on a particular health issue generated by each discipline
3. Integrate that knowledge
4. Demonstrate the value of the various disciplinary approaches to generating a more holistic understanding of the particular health problem.

This was achieved by asking each fellow at the start of the JAS to announce the discipline from which they came. In keeping with a problem-centering strategy for multidisciplinary research training,¹⁵ fellows then worked in discipline-specific groups to undertake a literature search on maternal mortality, drawing on publications and using search engines from their specific discipline. They then summarized these articles and reported back to the entire group: what their discipline was about, the methodologies that it employs, the publications they found, and what was elucidated by their discipline on maternal mortality. Then, using an interactive teaching method – a multi-level framework for understanding the social determinants of health (ref.²⁷: 111–17) – we explored the factors that influence excess maternal mortality, using data accumulated from all represented disciplines.²⁵ This approach had multiple learning outcomes (such as learning to search different databases, using a reference manager, summarizing and synthesizing articles). At the same time, importantly, it introduced fellows to various disciplinary traditions, methods and knowledge generated from each discipline and drew attention to how, in combination, the approaches provided a more holistic picture of the various interventions that might be required to decrease maternal mortality. Through this learning approach, fellows generated for themselves an understanding of why acceptable services might be as important as quality services, and why infrastructure such as roads might have as important an impact on maternal mortality as the provision of antenatal care.

Box 2. Triangulating data – A pedagogic approach used in JAS2

The aim of this exercise is to:

1. Develop skills in using various analytic tools, both quantitative and qualitative
2. Enforce teamwork
3. Promote triangulation of data
4. Encourage the use of unfamiliar research methods.

This was achieved by teaching fellows to use qualitative and quantitative data analysis tools (in our case, NVIVO and STATA). The fellows were then divided into mixed-disciplinary groups, and each group was provided with the same sets of qualitative and quantitative secondary data from previous research projects. They were required to analyze both data sets using the tools they had been taught, to triangulate the data, and to develop a conference-style poster summarizing their findings. Among other learning outcomes, they gained familiarity with unfamiliar methodological approaches and tools, relied on the expertise of others in the group with a background in the approaches about which they are less knowledgeable, and used the data to make sense of a public health problem.

Box 3. Communicating across disciplines – A pedagogic approach used in JAS3

The aim of this exercise is to encourage fellows to:

1. Make their own research understandable to a multidisciplinary audience
2. Simplify the work, without diluting its meaning, to make it accessible to a more generalist audience.

This was achieved by providing an opportunity for each fellow to present his or her work to colleagues and facilitators at JAS3. At this point, all fellows had completed data collection and were writing up their doctorates, either with papers for publication or as a monograph. They were expected to present a seminar describing their findings, in a way that ensured that all present could understand their work, regardless of disciplinary background. Thus, someone doing mathematical modeling had to present his or her work in a manner understandable to a social scientist using discourse analysis, and vice versa. Questions were posed by the audience about the content, and feedback was provided about the understandability of the presentation. This approach ensured that candidates were able to interpret their findings clearly, and the exercise emphasized to fellows the need for comprehensibility in translating and disseminating research to non-scientific audiences as well as to scientists from other disciplines. Such communication skills are an essential part of multidisciplinary capacity, in keeping with what others have described as “Interdisciplinary Communicative Competence”.²¹

teaching program (see Table 2). We solicit both qualitative and quantitative data on how the fellows perceived the teaching as influencing their intellectual development. The quantitative element employed a 5-part Likert scale, with 5 as the best score, and here we report the median score. We also report data from a survey conducted with Cohort 2 fellows. Verbal informed consent was obtained to use these anonymized data. We have also drawn from an external independent evaluation of CARTA conducted by an international consultancy.¹⁸

We classified PhD fellows, supervisors and JAS facilitators by discipline, adapting the International Standard Classification of Education.¹⁹ The 93 CARTA fellows from the first four cohorts, enrolled into the CARTA program between 2011 and 2014, and their 97 supervisors for Cohorts 1–3 were classified according to their reported background disciplines. As co-supervision is common,

there are more supervisors than PhD fellows. The supervisors for Cohort 4 are not included as, at the time of writing, they had not been finalized. The 160 facilitators who participated in at least one of the residential seminars were classified using their own descriptions of their areas of skill. Some facilitators had very specific functions, to support writing skills or leadership training; they were classified in the UNESCO field of education and leadership rather than by their original discipline.

RESULTS**Multidisciplinary mix of PhD fellows, supervisors and JAS facilitators**

CARTA PhD fellowship calls are distributed at each university in various ways: some canvass the entire university; others target

Table 2. Data collected for evaluation of Joint Advanced Seminars

Fellows' PhD research project descriptions
Minutes of the curriculum planning meetings
JASs curriculum and teaching timetables
Facilitators' reflective notes compiled during the JASs
Students' evaluations completed during the JASs (each session or group of linked sessions were evaluated online by the PhD fellows, as was an online summative evaluation of the complete JAS – using both quantitative 5-point Likert scales and open-ended questions)
Biographic data from CARTA administrative databases of PhD fellows, facilitators and supervisors
External, independent evaluation of CARTA

social science and medical faculties. CARTA fellows come from a wide range of disciplinary backgrounds (Table 3). This range is key to multidisciplinary training.^{20,21} While there are more fellows from disciplines directly related to public health, including the social and behaviour sciences, PhD fellows also come from disciplines that do not traditionally engage in public health issues, such as engineering, education, media studies and political science. There are also fellows from clinical and laboratory-based disciplines in which a public and population health approach is unusual, as is the use of qualitative research methods.

The CARTA supervisors also came from a wide range of disciplines (Table 4). We rely on the supervisors to provide the disciplinary depth required for the PhD fellow, but also hope that they will be open to the breadth of vision that we aim to inculcate in CARTA fellows, including our anti-hierarchical approach. This aspect of the program was praised in a recent independent review:

"[D]ue to the somewhat unique relationships CARTA fosters between (fellows) and supervisors, characterised as 'a more collegial relation' in which 'students get to complain about

Table 3. Disciplinary background of CARTA fellows, Cohorts 1, 2 and 3

Fields	Includes individuals who described their area of specialization as:	No.
Population sciences	Demography, Population studies	11
Statistics and mathematics	Statistics, Mathematics	8
Public health	Public health, Nursing, Monitoring & evaluation	14
Epidemiology	Epidemiology	3
Clinical disciplines	Clinician, Physiotherapy, Haematology, Nursing	17
Social sciences, Humanities and Development studies	Literature, Social science, Geography, Economics, Psychology, Political science, Sociology, Social epidemiology, Social work	11
Information sciences	Library science, Media communication	4
Natural sciences	Nutrition science, Environmental science, Biology, Medical microbiology, Parasitology, Biotechnology & Chemistry, Pharmacology, Laboratory science, Zoology, Immunology, Nutrition, Pharmacology	19
Education and leadership	Education	1
Engineering	Engineering	1
Total		89

*supervision due to the (student-supervisor)contract'. Supervisors also benefit from their relationships with fellows, describing it as 'fantastic' and 'two-way' and lauding 'the networking aspect where you meet students from various universities and you advise them'."*¹⁸

An important component of the CARTA provision is the kind of academics that facilitate the residential seminars. They also have diverse disciplinary backgrounds (Table 4). Not surprisingly, academics who volunteer to support these seminars have eclectic backgrounds, reflecting research values consistent with those promoted by CARTA. Some do research informed by more than one discipline, using mixed methods research, and cross disciplinary boundaries as a matter of course. Other facilitators work in two disciplinary areas: a qualified doctor works as a clinician and has a PhD in sociology; an epidemiologist is recognized in the field of health promotion; a natural scientist is involved in developing government policy; a cardiologist had a degree in philosophy. Some facilitators are experts in quantitative or qualitative research and have never ventured outside of these realms, but appreciate both; others have extensive experience in mixed methods research.

PhD fellows' experience of multidisciplinary training

Fellows completing the evaluation forms for JAS1, the first residential seminar, indicated (median scores of 4 or 5 between cohorts) that JAS1 demonstrated that multidisciplinary research is important to achieve positive public and population health outcomes; had given them a vocabulary to understand other disciplines; and had enabled them to assess a paper in a discipline other than their own. Furthermore, they indicated, again with median scores of 4 or 5, that the introduction to other disciplines had changed the way they viewed their own research and had affected how they conceptualized and designed their PhD project. Some reported making changes to their research question, choice of literature, study design and analysis plan. One fellow wrote:

"I never thought of how law could influence healthcare provision for the aged, especially in terms of access to post-reproductive care services. ... I am trying to expand my research ... in this direction". (Cohort 2)

Another said "the session on research methods made me think of doing my work as a mixed study" (Cohort 3). Another wrote: "I learned something about the approach of other disciplines (e.g., methods or their theoretical underpinnings) that I did not know before". (Cohort 4)

Feedback from PhD fellows on JAS2 (median scores 4 or 5 across 3 cohorts) confirmed that JAS2 introduced fellows to a variety of research methods and the ability to use methods that were new to them. One PhD fellow, a quantitative researcher, wrote:

"Qualitative research methods – ethnography, etc. I had heard about these methods and read about their use in publications, but was not aware of how to use these methods". (routine JAS2 evaluation data)

Another, appreciating the complementary nature of qualitative and quantitative methods, reported:

Table 4. Disciplinary background of CARTA Supervisors and Joint Advanced Seminar facilitators

Fields	Includes individuals who described their area of specialization as:	CARTA supervisors*	JAS facilitators
Population sciences	Demography, Social demography, Medical demography, Population & Reproductive health	14	11
Statistics and mathematics	Statistics, Biostatistics, Epidemiology and biostatistics, Medical statistics and demography	11	16
Public health	Public health, Health promotion, Epidemiology, Global health, Epidemiology & Public health, Epidemiology & Health promotion, Health policy, Health systems, Community health, Community rehabilitation, Nursing, Occupational health, Occupational medicine, Pathology & Occupational health, Occupational hygiene, Occupational & Environmental health, Preventive medicine, Family medicine and health systems	12	35
Epidemiology	Epidemiology, Clinical epidemiology, Epidemiology & Biostatistics, Spatial epidemiology & Biostatistics, Epidemiology of NCDs, Field-based epidemiology & Nutrition	9	26
Clinical disciplines	Clinical medicine, Obstetrics & Gynaecology, Oncology, Cardiovascular medicine & Public health, Paediatrics, Surgery, Research methods in medicine	16	7
Social sciences, Humanities and Development studies	Social anthropology, Medical anthropology, Sociology, Medical sociology, Philosophy of science, Language, Literacy & Culture, Creative writing & Literature, Economics, Economic history, Health economics, Psychology, Ethics & Community engagement, International political economy, Communications, Law, Medical Law, Community development, Behavioural studies	12	36
Information sciences	Library studies, librarianship	2	3
Natural sciences	Immunology, Applied microbiology, Molecular biology, Malariaology & Environmental health, Cellular parasitology, Pharmacokinetics, Physiology	16	5
Education and leadership	Education, Mathematical education, Intercultural leadership education, Educational research	1	19
Business administration	Finance management, Business management	0	2
Total		93	160

* Supervisors of Cohorts 1, 2 and 3 only, as Cohort 4 are still finalizing supervisors; a supervisor can be supervising more than one CARTA fellow.

“Both approaches to data analysis are equally relevant depending on which question we need to answer”. (routine JAS2 evaluation data)

In the survey of Cohort 2 fellows held during their third seminar (JAS3), 14 (of 18) fellows described their usual methodological approach as quantitative. However, 5 of those 14 reported that they were now using mixed methods in their doctoral research – an indicator used to assess whether research is multidisciplinary.²²

“I can now understand a qualitative paper and critique [it]. Also I now think outside the quantitative box when asking research questions”. (Cohort 2 survey)

“I now believe mixed methods approach is a better way to advance our knowledge in answering or solving many of the health problems facing our countries. After JAS2, I joined the social science network at my home institution and I actively participate with the hope to learn and acquire more skills in qualitative research”. (Cohort 2 survey)

“In my challenge of collecting data, I have been able to use other methods to enhance my data – focus group discussion. I am now interested how research informs policy”. (Cohort 2 survey)

Three fellows also reported that they were using mixed methods in research outside of their PhD studies:

“Training on mixed methods has influenced me. I applied for a local institution competitive grant using mixed methods approach to explore noise pollution in a teaching hospital. I won the grant and I have already completed the qualitative aspect of the study – my first attempt at qualitative research!!” (Cohort 2 survey)

Cohort 1 fellows confirmed that new methodological skills were learned and learning from each other was part of that process.²³

DISCUSSION

CARTA has successfully attracted PhD fellows from a range of disciplines to undertake research related to public health. They have found appropriate supervisors for their studies, sometimes drawn from more than one discipline. To enhance the multidisciplinary research training of these PhD fellows, CARTA has developed and delivered multidisciplinary modular seminars within which the pedagogical approach creates spaces for multidisciplinary interaction and learning, while concurrently providing rigorous teaching for conducting research. The PhD fellows participating in this program have gained insight into the value and role of multidisciplinary research. They have an ability to engage with researchers from other disciplines and conduct research using methods from different disciplines. For some PhD fellows, the training led to them to change the direction or structure of their research and to integrate research methods that were new to them.

Although the multidisciplinary curriculum development and facilitation process was demanding intellectually, emotionally and in terms of time commitment, as reported by other studies,¹⁴ fellows embraced this approach. Several reported fundamental changes to how they understood the research process, the development of research protocols, and the nature of the public health questions in which they were interested, again reflecting the experiences of others involved in multidisciplinary programs.^{24,25} CARTA fellows have also found ways to communicate better to a wider range of disciplinary colleagues, in keeping with one of the key principles for nurturing multidisciplinary research.^{6,7,26}

We have not yet found a way to assess whether each PhD fellow gains sufficient breadth and depth. We have not assessed whether multidisciplinary training makes for a better statistician or social scientist, although we are confident that our PhD fellows can engage meaningfully across disciplines. While the CARTA training has role-modelled and reinforced non-hierarchical relationships

among individuals, disciplines and approaches to research and demonstrated values of respect for difference, this may not be enough.²⁶ The world of science, government, funding agencies, universities and research institutions is largely still structured around scholarly disciplines, and in the context of conservative institutions, we do not know if the ability of CARTA fellows to work across disciplines or maintain anti-hierarchical values will be sustained.

The development and delivery of this multidisciplinary health research training was prompted by the need for research to be undertaken in a context-sensitive way to help solve major complex African health problems. Our process evaluation suggests we are on the right path, but longer-term follow-up to assess CARTA's impact on the production of research evidence and its impact is needed.^{6,22,26}

Although we are working in sub-Saharan Africa, our model has international relevance. Globally, there are major health challenges that need to be addressed by innovative research. The approach we have developed could be adapted to other contexts and would prepare PhD candidates to address the complex health problems they will face.

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RÉSUMÉ

OBJECTIFS : Élaborer le curriculum de « séminaires communs avancés » (*Joint Advanced Seminars* [JAS]) au sein du consortium CARTA (Consortium for Advanced Research Training in Africa) pour produire des titulaires de bourses de doctorat qui comprennent que la santé est le résultat de nombreux déterminants dans des environnements complexes et qu'il faut faire appel aux démarches d'un éventail de disciplines pour aborder la santé et le développement. Nous avons cherché à attirer dans ce programme des doctorants, des superviseurs et des membres du corps professoral d'un éventail de disciplines.

MÉTHODE : Des équipes multidisciplinaires ont élaboré le curriculum des JAS. Les bourses de doctorat du CARTA étaient ouvertes aux universitaires des établissements membres du consortium, indépendamment de leur discipline principale, intéressés à faire un doctorat en santé publique et des populations. Les superviseurs et les membres du corps professoral des JAS ont été recrutés dans les établissements du CARTA. Nous utilisons les données d'évaluation systématique des JAS (questions dirigées et non dirigées) recueillies auprès des doctorants après chaque JAS, un sondage auprès d'une cohorte du CARTA et une évaluation externe du CARTA pour évaluer l'impact du curriculum des JAS sur l'apprentissage.

RÉSULTATS : Nous décrivons notre démarche pédagogique, en faisant valoir qu'elle est au cœur d'une appréciation de nombreuses disciplines, et nous montrons en quoi elle favorise le travail multidisciplinaire. Le CARTA attire des doctorants, des superviseurs et des membres du corps professoral des JAS issus d'un éventail de disciplines. Les évaluations indiquent que les titulaires de bourses de doctorat apprécient mieux l'importance des disciplines autres que la leur pour comprendre la santé et ses déterminants et qu'ils ont l'appréciation et la capacité nécessaires pour employer des méthodes de recherche mixtes.

CONCLUSIONS : À court terme, nous avons réussi à mieux faire comprendre la multidisciplinarité, ce qui fait que nos doctorants utilisent des méthodes extérieures à leur discipline d'origine. Ce curriculum peut être appliqué dans d'autres pays.

MOTS CLÉS : renforcement des capacités; recherche; pays en développement; Afrique subsaharienne; multidisciplinarité