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Towards a competency-based doctoral curriculum at the University of Zambia: lessons from practice

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We describe a collaborative, iterative, and participatory process that we undertook to develop and adopt a competency-based doctoral curriculum framework at the University of Zambia. There needs to be more than the traditional unstructured apprenticeship of PhD training in a knowledge-based economy where PhD graduates are expected to contribute to industry problem-solving. The lack of industry-driven competencies and, to some extent, limited skills possessed by PhD graduates relative to the demands of employers has led to the misclassification of doctoral degrees as mere paper certificates. Further, under traditional PhD training without specific core competencies, it has led to criticisms of such PhD studies as a waste of resources. The calls to rethink doctoral development in broader employment contexts led many countries to redesign their PhD programs. Training has increasingly introduced industrial linkages and industry-defined research projects to increase the attractiveness of doctoral students. Whereas developed countries have made significant reforms towards competency-based PhD training, little or nothing has been done in developing countries, especially in sub-Saharan Africa. This against the demands that Africa needs more than 100,000 PhDs in the next decade to spur economic development. Against this background, the University of Zambia has developed an industry-driven structured competency-based PhD curriculum framework. The framework will guide and support the development of standardized program-specific PhD curricula, delivery, and assessment of competencies at the University of Zambia, ensuring that doctoral students acquire skills and demonstrate core competencies that are transferable and applicable in industry settings. This framework focuses on the development of specific competencies that are necessary for successful PhD completion. The competencies are divided into three main categories: research, teaching, and professional development. Each category is then broken down into ten core competencies from which respective doctoral programs will develop sub-competencies. It is from these core competencies and sub-competencies that learning outcomes, assessment methods, and teaching activities are developed.

It is envisioned that this new competency-based doctoral curriculum framework will be a helpful tool in training a cadre of professionals and researchers who benefit the industry and contribute to economic and societal development.

KEYWORDS

competency-based framework, curriculum development, formative and summative evaluation, doctoral training, iterative participatory process

1. Introduction

The Doctor of Philosophy degree (PhD) was first introduced in 1810 in Germany and was then incorporated into higher educational institutions into the United States of America (USA) in 1862, Canada in 1900, the United Kingdom (UK) in 1917, and Denmark in 1989, and then more globally (Mulvany, 2013). It was initially meant for academia, but the narrative has changed over the years with the belief that applying PhD knowledge and acquired skills can solve society's problems and contribute towards better economies (Cloete et al., 2016). This has called for building competencies in PhD graduates beyond their academic career to be able to solve problems for the industry and society at large. Traditionally PhDs were unstructured with the belief that a candidate would pick up the skills during an academic journey under the supervision of an advising professor, with participation in conferences, workshops, seminars, and publications not being obligatory but a thesis (monograph) as an end product (Mulvany, 2013). Many institutions in many countries worldwide have continued with the traditional unstructured apprenticeship way of PhD training despite most graduates going into the industry to contribute towards a knowledge-based economy without requisite industry-driven competencies (Mulvany, 2013; Fredua-Kwarteng, 2023). Doctoral graduates are critical players in knowledge production, dissemination, application, and innovation in a knowledge-based economy (Bryan and Guccione, 2018). This has led to criticisms that PhD studies are a waste of resources because they train people “clones” who overspecialize with little or no generic or transferable skills to address industry problems beyond academia (The Economist, 2010; Taylor, 2011). Many scholars argue that universities are producing too many graduates for too few academic jobs, and graduates lack skills that enable them to be productive in jobs outside academia or in a broader economic sector, a term which the authors called a “PhD crisis” (Cyranoski et al., 2011; Taylor, 2011; Cuthbert and Molla, 2015). Taylor (2011) argues that there should be reforms to the traditional unstructured apprenticeship “middle age” model of PhD training towards industry-driven competency-based PhD training because doctoral graduates are no longer restricted to the walls of academia. These calls to rethink doctoral development in broader employment contexts led many countries to redesign their PhD programs (Bryan and Guccione, 2018). Training has increasingly introduced industrial linkages and industry-defined research projects to increase the attractiveness of doctoral students (McGagh et al., 2016).

Developed countries have made significant reforms to address these problems. For instance, Europe started these reforms using the Salzburg recommendations from the Bologna Seminar' on Doctoral Programs for the European Knowledge Society (Christensen, 2005).

The Salzburg recommendations state that reforms must: “prepare doctorates for academic and non-academic employment; build transferable skills of graduates and institutionalizing career development opportunities; and achieving critical mass through interdisciplinary, institutional, intersectoral, regional and international collaboration (Christensen, 2005).” The United States and Australia are the other developed countries that have moved towards competency-based PhD training (Cuthbert and Molla, 2015). Universities in the developing world, especially in Africa, predominantly use the traditional apprenticeship PhD training model, which has faced much criticism (Cloete et al., 2016; Fredua-Kwarteng, 2023), as hinted earlier. South Africa realized early that the apprenticeship model was inadequate for the country's needs and developed five PhD models (Cloete et al., 2016). There has been debates for Africa to train more than 100,000 high-quality competency-based PhD in a decade to yield the research the continent needs for accelerated development through job creation and opportunities as well as addressing challenges it faces in areas such as climate change, diseases, food security and political instability (Waruru, 2022; Fredua-Kwarteng, 2023). This paper presents the practical collaborative, iterative, and participatory process of developing a structured competency-based PhD curriculum framework to reform PhD training at the University of Zambia (UNZA).

Competency-based training has been around for quite a while but implementing it widely in PhD training is a relatively new idea (Kim, 2015). This is because, unlike bachelors and masters training with professional bodies and associations that ensure that core competencies are included in a program to respond to economic and social systems, a PhD program often lacks accrediting bodies that require specific competencies (Mulvany, 2013; Cuthbert and Molla, 2015). Competency-based curriculum means learning and assessment based on generic and transferable skills (Loisy, 2018). This is learning organized around prescribed competencies or abilities over a long list of knowledge objectives (Frank et al., 2010; Iobst et al., 2010). In a competency-based training system, the progression unit is mastery of specific knowledge and skills and is learner-based or self-paced learning which builds independence and self-reliance (Watson, 1990; Sullivan and McIntosh, 1996). According to the Rhode Island Department of Education (RIDE), “a curriculum is a standard-based sequence of planned experiences where students practice and achieve proficiency in content and applied learning skills.” In our context, a structured competency-based PhD curriculum framework is a document that will guide the development of standardized program-specific PhD curricula, delivery, and assessment of competencies at the UNZA. This means that a PhD program must demonstrate that the doctoral student has acquired skills and can demonstrate all

aspects of the core competencies in the curriculum without prescribing the learning theory to teachers. Teachers can use any learning theory, whether behaviorist, cognitive constructivist, or social constructivist, provided the outcomes are assessable (Iobst et al., 2010).

2. Methodology

2.1. Rationale for developing a competence-based PhD curriculum framework

The University of Zambia's PhD programs have been offered in various schools since its founding in 1965 (UNZA, 2018). The structure of these programs has varied among schools, in some instances departments, even within the same school. Furthermore, most PhD programs were research-based with no structure or formal curriculum document guiding the learning to ensure the learner acquired the key competencies. The process has had varied outcomes regarding basic competencies required of PhD candidates depending on factors that include: the program, supervisor, student, department, institution, and funder. These factors are global, as highlighted by Verderame et al. (2018). There have been arguments that the quality of PhD training needs to be improved because some students are not effectively guided, resulting in a high attrition rate and some candidates taking a longer duration of completion. Even some who graduated lack computation, analytical, and other general and transferable skills, making it challenging to conduct independent research and survive in the industry. The factors affected the enrolment levels as candidates shunned the local qualification in preference to foreign universities. This has impacted the training of 21st-century independent researchers who should stand beyond their supervisors. To address these challenges and those highlighted by other researchers in the introduction section, the University of Zambia developed and adopted a Structured doctoral curriculum framework to guide uniform discipline-specific competency-based learning.

2.1.1. Historical perspective of the process towards the curriculum framework

The journey towards a structured PhD curriculum model at the UNZA began in 2016 supported by a five-year (2015–2020) NIH grant No. 5D43 TW009744 between the UNZA and Vanderbilt University in the United States. It started with a training needs assessment which identified a need to develop a structured PhD program with standard, year-long research, and other core skills. Several school meetings in 2017 generated a four-year program structure incorporating didactic coursework in the first year based on guidance from the needs assessment. This was championed by the four health science-based schools, including Health Sciences, Public Health, Nursing Sciences, and Medicine.

In 2018, another force emerged with a presentation of a position paper to the School of Veterinary Medicine Board of Graduate Studies by the first author, having been trained through a similar process at the Norwegian University of Life Sciences. After approval of the position paper by the school, it was submitted to the Senate Board of Graduate Studies (an arm of the Senate in charge of graduate studies) for further approval. Senate appointed an *ad-hoc* committee comprising senior professors and assistant deans-postgraduate studies

from science-based schools to oversee the implementation of the proposed framework. The *ad-hoc* committee proceeded for a one-week retreat to consider the position paper and develop modalities for implementing a structured PhD curriculum. However, the *ad-hoc* committee approved the position paper and revised the guidelines without providing a curriculum framework making implementation of a competency-based PhD training challenging.

In 2019, the team from Health Sciences, Public Health, Nursing Sciences, and Medicine with Vanderbilt University held a workshop to develop a curriculum for a structured PhD. They invited the team from the School of Veterinary Medicine, which had already presented the position paper to the Senate. It was agreed from the workshop that all health science-based schools should put their efforts together and develop a structured competency-based PhD curriculum framework which would guide curriculum developments in various schools, departments, institutes, and units since the Higher Education Authority (HEA), which is the regulatory body of higher education in Zambia did not have a framework making implementation of a competency-based PhD training challenging. The UNZA/Vanderbilt team had already conducted a training needs assessment which the workshop adopted to move to the next level. This exercise taught us the importance of collaboration and sharing common resources within and between schools, universities, and research institutions to achieve similar goals. The Salzburg recommendation highlights the importance of institutionalizing career development opportunities; and achieving critical mass through interdisciplinary, institutional, intersectoral, regional, and international collaboration toward efforts to reform PhD training (Christensen, 2005).

In August 2020, the collaborative process of developing a competency-based structured doctoral curriculum framework started with a six-day workshop with 22 participants from schools of Health Sciences, Medicine, Nursing Sciences, Public Health, and Veterinary Medicine.

2.2. The iterative participatory process of developing the competency-based PhD curriculum framework

We followed principles of Competency-Based Education (CBE) recommended by several authors (Foyster, 1990; Watson, 1990; Johnstone and Soares, 2014; Kim, 2015; Pinto et al., 2023), which include the identification of core competencies by the stakeholders, mapping competencies to courses, and developing competency-based assessments for training doctoral students as shown in Figure 1.

2.2.1. Identification of core-competences

According to Johnstone and Soares (2014), “core competencies in programs should align with both industry and academic expectations, with the process by which they are developed being explicit and transparent. Program-level competencies should reflect the skills and knowledge students need at the following stages of their development, whether it be further education or employment.”

To respond to these recommendations, the first workshop started with a plenary session of a gap analysis exercise by the participants (divided into five random groups) which identified the current challenges in PhD training at the UNZA. Each group identified challenges based on their experience teaching and apprenticeship.

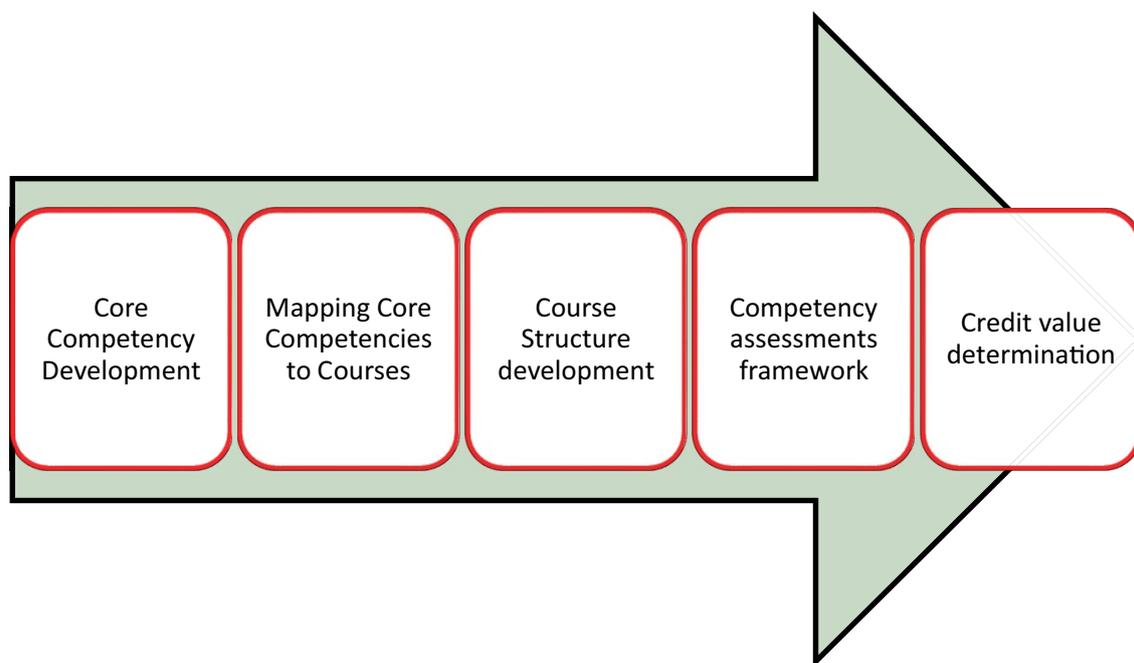


FIGURE 1

Summary of steps followed in developing a competence-based doctoral curriculum framework at the University of Zambia.

This was followed by a presentation of the training needs assessment report from the industry stakeholders for a comparison with the gaps the workshop participants identified. This information was used to identify the PhD tracks that would inform the development of a competency-based curriculum framework. For instance, the PhD tracks for the School of Veterinary Medicine included Veterinary Clinical Sciences, Veterinary Biomedical Sciences, Veterinary Epidemiology and Economics, Food Safety and Risk Analysis, One Health Microbiology, and Parasitology.

After identifying the PhD tracks, the participants went into a plenary session to develop a list of core competencies that would respond to filling the gaps identified by industry stakeholders and experts in various disciplines in life sciences. The selection of discipline-specific industry stakeholders was fully controlled by the respective schools through their departments. The groups made presentations of the core competencies they had identified, which were then compiled after discussing those not common in various groups. There was consensus to eliminate those competencies, which did not satisfy the identified gaps and required skill sets for doctoral graduates as guided by the Salzburg recommendations. The core competencies by [Verderame et al. \(2018\)](#) showed prominence and guided the plenary session.

2.2.2. Mapping core competencies to courses

According to [Johnstone and Soares \(2014\)](#), after establishing competency framework, academic teams need to translate them into topics that can be formulated into courses of the appropriate length and complexity. Curriculum mapping is a process used in education to align courses, assessments, and learning objectives with the overall goals of a program ([Johnstone and Soares, 2014](#)).

To respond to this, the first workshop in 2020 ended with a plenary session to identify the courses that would impart those core

competencies to all doctoral graduates in life sciences at the UNZA, depending on the identified PhD tracks. A PhD track allows students the flexibility and structure to obtain further specialized training in selected topic areas in addition to the core education provided by their program area requirements. Each group was formed based on expertise within each PhD track and presented the courses they identified and identified persons to coordinate and teach each course depending on expertise in each PhD track. The participants then grouped courses into mandatory, discipline-specific, and electives. There was consensus to eliminate courses believed to be outside the required core competencies. The participants identified the courses offered at different levels and those that needed development. After concluding the workshop, representatives from each School were charged with developing the course syllabi. A smaller group was tasked to compile a curriculum framework. It was agreed that the next workshop would be called when all groups, according to schools and PhD tracks, submit their respective assignments.

2.2.3. Development of competency-based assessments

According to [Johnstone and Soares \(2014\)](#), Assessments are an essential component of the teaching and learning process, as they provide students with feedback on their progress and help educators determine whether learning objectives have been achieved. However, to be effective, assessments must be carefully designed and tested to ensure their validity and reliability. By involving subject-matter experts and conducting pilot testing, educators can ensure that their assessments are fair, reliable, and valid measures of student learning ([Johnstone and Soares, 2014](#)). This, in turn, helps to ensure that students are adequately prepared for the challenges they will face in their future academic and professional endeavors.

TABLE 1 Stakeholder composition.

Organization represented	Number of participants
Academia	14
Regulatory authority	2
Professional associations	1
Policy makers (Government Ministries)	2
Technical colleges	1
International donor organizations	1
Public practice	1
Private practice	1
Student representatives (undergraduate)	1
Student representative (postgraduate)	1
Industry, cooperatives	3
Research institutions	2

To respond to this, a second five-day workshop with 28 participants was organized in June 2021 to complete the curriculum framework. This workshop started with a presentation on the curriculum development process by the second author, who specialized in Medical Education. This changed the approach to concentrating on finetuning the core competencies, identifying the required skill set, identifying the required category of courses, allocating credit points to them, and then providing the assessment methods for core competencies. Reference was made to the Higher Education Authority PhD guidelines. We used assessment rubrics developed by [Verderame et al. \(2018\)](#) to construct different assessment methods. There was an emphasis on course-based assessments to aid teaching and learning as opposed to a traditional way of grade-based assessments. Grades are evaluations that represent the student's overall proficiency but do not tell you about the student's performance on individual learning competencies ([Stassen et al., 2001](#)). Participants were divided into groups, given the rubric metrics and core competencies, and asked to develop assessments verifying that the candidate had acquired the generic and transferable skills. Another group worked on grouping courses into categories of mandatory, discipline-specific, and electives. A careful apportionment of credit points to each category was done depending on the different types of doctorates, e.g., taught, part taught, and research, defined in the results section. This workshop developed a draft ready for the industry and other stakeholders. An online survey was then developed based on the identified PhD tracks, core competencies, and assessment methods in the draft competency-based curriculum framework. These were sent to industry stakeholders as a second training needs assessment tool to assess if they were responding to the gaps which they had identified initially. This validation process is essential in developing a competency-based curriculum, as guided by [Johnstone and Soares \(2014\)](#).

A third one-day workshop for all stakeholders (30 participants) indicated in [Table 1](#) was conducted. The draft document was sent to stakeholders 4 weeks before the workshop with a weekly reminder. All stakeholders were requested to present their input on the competency-based PhD framework. The workshop and

Training Needs Assessment survey comments were compiled and used to develop the curriculum framework, which was now ready for submission to Senate for approval. The draft curriculum framework was sent to the Senate Board of Graduate Studies for approval, but the board declined to approve it in the spirit of leaving no one behind (collaborative). The Senate Board recommended that the framework get a university-wide acceptance before approval by the full Senate. This meant getting input from all 13 schools (faculties) and disciplines in the University of Zambia instead of the initial approach of involving science-based schools only.

A fourth five-day workshop with 38 participants was organized for all assistant deans-postgraduate studies and deans from all 13 schools (faculties), institutes, directorates, and units in the University. The draft curriculum framework was sent to all the identified participants 4 weeks before the workshop. Each school was tasked to have departmental meetings to consult all academic members of staff and the school board of graduate studies to give input to the doctoral curriculum framework and revised postgraduate guidelines for presentation at the workshop. The workshop extensively revised the competency framework, course categories, course structure, and competency assessment framework and determined credit value for each PhD type, as summarized in [Figure 1](#). The four authors (first, second, third, and last) facilitated the big university-wide workshop and consolidated the final doctoral curriculum framework and postgraduate guidelines for final senate approval. The curriculum framework was approved by Senate and circulated to guide the development of various PhD curricula in different schools and disciplines at UNZA.

3. Results

All schools approved and adopted the competency based doctoral curriculum framework which was initially developed by the science-based school. Each school provided a list of programs ([Supplementary Tables S1–S3](#)) which they would structure into the three types of doctoral using the competency-based curriculum framework.

3.1. Types of doctorate degrees

Three doctoral programs were identified and recommended in the competency-based doctoral framework to guide PhD curriculum development, delivery, and assessment of core competencies at the UNZA. These include the traditional PhD by Research, PhD by coursework and research (part-taught), and professional doctorates with limited research rigor (taught). Professional doctorates are thus not called Doctor of Philosophy but Doctor of a specific Discipline. The following section describes the three types of doctorate degrees to be offered at UNZA.

3.1.1. PhD by research

This is a PhD in which an individual undertakes original research and publishes three (3) peer-reviewed papers in an indexed and peer review journal as guided by the University of

Zambia postgraduate guidelines and regulations. This study model may also be referred to as a PhD by publications. Minimal courses will be included to ensure that the general competence framework for a doctorate candidate is achieved. Figure 2 illustrates the pathway to three types of doctorate degrees at the University of Zambia.

3.1.2. PhD by coursework and research (part-taught)

This is an integrated PhD that exposes individuals to a combination of taught materials, practical experience, and advanced research. This allows the candidates to learn subject-specific methodologies while building the transferable skills that will enable an individual to become a leader in their chosen profession. The candidate must publish two (2) peer-reviewed papers in an indexed and reputable peer-reviewed journal, guided by the UNZA postgraduate (PG) guidelines and regulations. This may also be referred to as a Part-Taught PhD. Figure 2 illustrates the pathway to three types of doctorate degrees at the UNZA.

3.1.3. Professional doctorates (taught and professional research project)

A professional doctorate focuses on applying research to practical problems, formulating solutions to complex issues, and designing effective professional practices within your field. Broad categories include examples of these degrees include Doctor of Business Administration (DBA), Doctor of Nursing Practice (DNP), etc. Figure 2 illustrates the pathway to three types of doctorate degrees at the UNZA.

This implies that any of the 13 schools (faculties) developing a doctorate degree curriculum at the UNZA must classify the program under one of the three types provided in the competency-based curriculum framework regarding the progression/pathway, competence framework, course structure, and assessments.

3.2. Competency framework

To develop the competency framework, we looked at the 2005 Salzburg recommendations (Christensen, 2005). Cuthbert and Molla (2015) summarized Salzburg's recommendation's reforms toward a competence-based PhD curriculum in three categories:

- i. Prepare doctorates for academic and non-academic employment.
- ii. Build transferable skills of graduates and institutionalize career development opportunities.
- iii. Achieving critical mass through interdisciplinary, institutional, intersectoral, regional, and international collaboration.

Having considered the Salzburg recommendations, we studied the competency rubric by Verderame et al. (2018) and the general competency framework based on the Zambia Qualifications Framework Level 10 requirements and standards (ZAQA, 2021). These competencies are divided into three main categories: research, teaching, and professional development. We developed ten core competencies from which program-specific sub-competencies can be developed in each curriculum for different programs. Upon successful completion of their respective doctoral programs, students will be able to:

- i. Create, conceptualize, design, and implement an investigation to generate new knowledge and/or adjust the design of the investigation in light of unforeseen problems. This means that the student must demonstrate Broad Conceptual Knowledge of a scientific discipline to engage in productive discussion and collaboration with colleagues across a discipline.
- ii. Employ expert judgments on complex issues in specialized fields, often without complete data, and communicate ideas and conclusions clearly and effectively to specialist and non-specialist audiences. This means the candidate must demonstrate deep Knowledge of a specific field by understanding the historical

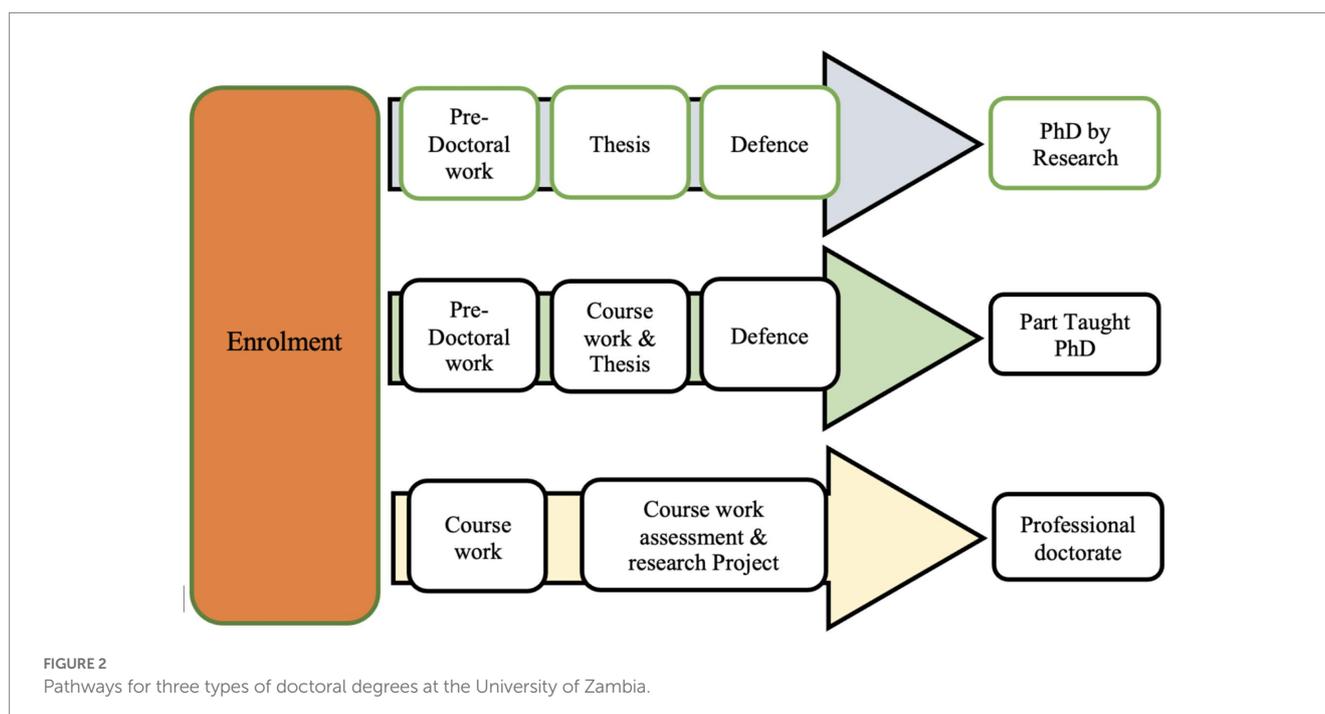


TABLE 2 Credit allocation for UNZA PhD.

PhD Type	Courses	Credits	Total Credits
PhD by Research	University Mandatory PhD Courses	60	360
	Elective Courses	20	
	Scholarship	20	
	Research Thesis	260	
Part Taught PhD	University Mandatory PhD Courses	60	360
	Discipline-Specific Courses	80	
	Elective Courses	20	
	Scholarship	20	
	Research Thesis	180	
Professional Doctorate	Coursework (including practice, i.e., clinical)	240	360
	Workshop/ seminar/ Conferences/ Journal Clubs	60	
	Research Report	60	

context, the current state of the art, and relevant experimental approaches for a specific field such as bioinformatics.

- iii. Undertake research and development at an advanced level, contributing substantially to developing new techniques, ideas, or approaches. Computational Skills encompass relevant statistical analysis methods and informatics literacy.
- iv. Employ qualities, ethics, and transferable skills necessary for utilization in varied contexts requiring the exercise of full personal responsibility and largely autonomous initiative in complex and unpredictable situations.
- v. Exhibit intellectual independence, authoritative judgment, adaptability, and responsibility as an expert and leading practitioner or scholar.
- vi. Undertake extended learning with a view to the continuous generation of new knowledge.
- vii. Develop and implement characteristics that sustain careers, such as motivation, perseverance, adaptability, participation in professional development activities, networking, and innovation skills. These are survival skills that every candidate must demonstrate to survive in a knowledge-based economy.
- viii. Demonstrate leadership and management skills, including formulating a research vision, managing group dynamics and communication, organizing and planning, making decisions, solving problems, and managing conflicts. Doctoral graduates take up leadership positions in and outside academia but mostly need to gain these skills because they were not taught

through a structured course that teaches leadership and management skills.

- ix. Demonstrate collaboration and team science skills, including openness to collaboration, self and disciplinary awareness, and integrating information across disciplines.
- x. Demonstrate communication skills, including oral and written communication skills and communication with different stakeholders.

3.3. Assessment methods

Unlike traditional training systems' assessment methods, which involve administering knowledge-based tests, competency-based training emphasizes evaluation based on mastering skills. Therefore, evaluation is based on recognizing the performance of a skill as satisfactory based on competencies set by the program (Sullivan and McIntosh, 1996). Therefore, the emphasis should not be on grade-based but on course-based assessments because the latter encourages mastery of individual competencies as opposed to overall proficiency of student performance in the course (Stassen et al., 2001). Assessments in the new paradigm of college teaching should be criterion-referenced or grading to predefined competencies through the use of performances and portfolios; continuous assessment of instruction (Fink and Fink, 2013).

In this curriculum framework, we used a combination of formative assessment in the first part and summative in the second part of a PhD program, otherwise referred to as the combination of the American and European systems as posited by Barnett et al. (2017). In formative assessment, the students are given continuous instruction or guidance on targeted competencies. In summative assessment, the focus is on the outcome or product of the candidate, which is primarily a thesis, a paper, and a defense, whereas formative assessment evaluates and summarizes the candidate's performance over time. We adopted the recommendation by Mulvany (2013), which states that "the ultimate best practice would encompass structured formative assessment at defined periods during the doctoral program, as well as an impartial final summative assessment." We allocated credit points to each type of a PhD to be provided at the University of Zambia, as indicated in Table 2. The credit points are based on notional hours with a minimum of 1,200 notional hours per year. One credit equals 10 hours as per the required standards by the Zambia Qualifications Authority (ZAQA, 2021).

The PhD by research has more weight on the thesis, which is more suitable for those who work in research institutions. However, they also do the mandatory courses, which include Research methodology, Philosophy, Ethics and Integrity in Science, Scientific Writing and Communication, Scholarship, and Leadership, Management, and Governance. These would be taken by all PhD candidates trained at the University of Zambia so that they all develop a standardized competency. Scholarship refers to a course designed to equip the candidate with lifelong learning skills and independent thinking. This competence is a necessary requisite for a PhD scholar, which allows the scholar to be aware of developments within their field of study and how to apply the emerging technology to their context. We designated elective courses that could be customized according to individual student focus during doctoral training. For instance, if the candidate

TABLE 3 Rubric for assessing competencies.

Core-Competence	Assessment tool/type
Broad conceptual knowledge of a scientific discipline	Public lecture
Deep knowledge of a scientific field	Thesis defense
	Publications
Critical thinking skills	Tests
	Assignments
Experimental skills	Midterm evaluation
	Seminar presentations.
	Logbooks
	Portfolio
Computation skills	Tests
	Assignments
Collaboration and team skills	Supervisor reports
Responsible conduct of research and ethics	Ethical clearance of protocol by IRB
	Supervisor reports and thesis defense.
Communication skills	Policy briefs
	Press statements
	Seminar & conference presentations
Leadership skills	Conference presentations and organization
Survival skills	Assignments
	Practical demonstrations

requires an extra course to conduct gene sequencing, they would do the program physically or virtually from a recognized institution and submit the content and duration of the course or module to assess credit units. A credit transfer policy was developed by the University management to guide the transfer of credits within and between institutions.

A taught PhD has an equal allocation of credit points divided between coursework and research, as shown in Table 2. Note the inclusion of discipline-specific courses, which carry more points to cater for additional competencies for the industry. We define competencies in line with the economic and societal needs of the industry rather than at the individual level, as recommended by Foyster (1990). For instance, for a PhD in food safety and risk analysis, the discipline-specific courses include food safety management, risk analysis, quality management systems, food safety at primary production, etc. This means that for a Ph.D. candidate to graduate, they should have skills in conducting a food safety risk assessment.

A professional doctorate like a Doctor of Nursing emphasizes discipline-specific coursework that imparts critical thinking and evidence-based practical skills to graduates. They conduct low-depth research and write a short research report examined as a course and not a thesis, as shown in Table 2. Mandatory courses and scholarship will not be required here, but candidates may be required to sit for them depending on the area of specialty. Special discipline-specific courses such as clinical rotation will include hours for practice (e.g., clinical, legal, pharmacy).

After mapping courses to competencies and allocating credits on which assessments would be done, we adopted Verderame's rubric against a checklist of assessment tools for each competency shown in Table 3 (Verderame et al., 2018). Assessing competencies is a critical component of competence-based training, and it is essential to ensure that the assessment methods are valid, cost-effective, and inclusive of various methods (Foyster, 1990). Effective record-keeping and maintenance of assessment standards are also important to ensure that learners can demonstrate their competencies and achieve the required qualifications. For this framework, assessments tools will include attendance and completion of assignments/tests for workshops/seminars, Written, Portfolio (Logbooks and Reflective assessment/learning), Assignments, Practical tasks, Presentations/Lectures, 360 evaluations, Thesis/dissertation, Publications, and Student reports.

4. Discussion

4.1. Learning outcomes of the collaborative, iterative, and participatory process of developing competence-based doctoral curriculum framework

From this five-year exercise of structuring our doctoral training, we learn that a collaborative, iterative, and participatory approach is a rigorous and effective way of developing a standardized competency-based curriculum framework that responds to societal needs (Wittmann-Price, 2020; Pinto et al., 2023). This is because it is a bottom-up approach involving all key stakeholders in the industry, thus developing society-based competencies instead of individual-based ones (Foyster, 1990). In the university context, this approach creates awareness and motivation among the stakeholders taking part in this curriculum framework-making process, which improves a buy-in from all schools or faculties to develop their curricula in line with the core-competencies in the framework (Mumba et al., 2017; Wittmann-Price, 2020). A case in point is the School of Veterinary Medicine, which developed six curricula for structured PhD programs in Epidemiology and Economics, Veterinary Biomedical Sciences, Veterinary Clinical Sciences, Veterinary Parasitology, Food Safety and Risk Analysis, and One Health Microbiology following this framework. The schools of Nursing Sciences developed four structured PhD curricula; Clinical Nursing, Public Health Nursing, Mental Health and Psychiatric Nursing and Midwifery. Each of the four main disciplines have specific specialized tracks. The School of Health Sciences also developed structured PhD curricula in Biomedical Sciences. This is opposed to the previous unstructured PhD system, which proved difficult due to the absence of a structure and lack of a standardized competency framework that schools or faculties could follow. We, therefore, learned that to transform PhD programs in line with the Salzburg recommendations (Cuthbert and Molla, 2015), the university needs a competency-based curriculum framework, which should guide the development of respective program-specific curricula, which in turn guides the development of postgraduate guidelines for a successful implementation of graduate training.

We also learned that the main challenge of this process is the high expenses in bringing stakeholders together and the long time it takes to complete the reforms from traditional PhD training to a

competency-based model. It took us 5 years and an estimated cost of US\$120,000 in workshops to complete the process. The long time was mainly because some collaborators and stakeholders would take a long to complete their tasks in bureaucratic systems of different institutions in the iterative process. Documents would go missing in some offices, rendering the previous input a waste of resources because the lead person or team would have to start afresh. Change of management in schools or faculties, directorates, and institutes and at top management delayed the process. Getting the new office bearers to quickly adopt the reform from the traditional PhD training to a competency-based model was a delay in the feedback system of the policy change.

Another lesson we learned was that there is a need for a robust and knowledgeable person to lead and explain the benefits of reform to schools or faculty and articulate the vision of the final product to faculty and management, as stated by [Wittmann-Price \(2020\)](#). Without such a leader, the process can be frustrated by a bureaucratic system in universities and institutions and affect change. Another lesson we learned was the need for active and extensive communication so that all academic members of staff are informed of the process and the changes since they are the ones that will implement the structured doctoral training. Our lapses in communication at the beginning affected the approval process as other schools and units felt that they needed to be consulted and informed despite the initial plan of restricting the structured curriculum framework to life science-based schools. The delay was, however, necessary as it engaged all academic staff in each department, schools/faculty, directorates, and institutes in the university and improved a buy-in by over 800 academic members of staff.

4.2. Implications of implementing a structured competency-based curriculum framework

Implementing a structured competency-based PhD curriculum framework at the University of Zambia has implications for teaching and learning. The development of respective curricula should have some of the following key considerations that will successfully link competency to the curriculum:

4.2.1. Clear understanding of competencies

Before implementing a Competency Based Training (CBT) system, it is important to understand the competencies required for each role in the school ([Wittmann-Price, 2020](#)). This will involve conducting a thorough job analysis and identifying the skills, knowledge, and behaviors required for success in each role.

4.2.2. Assessment of current skills

The individual schools must assess their employees' current skills and competencies to identify gaps and determine where training is needed.

4.2.3. Design and delivery of training

The schools must design and deliver training programs aligned with the competencies required for each role. This may involve developing new training materials or modifying existing ones ([Fink, 2005](#)). The question the developers must ask is, what content is needed

to support the development of competency in the curriculum? What instructional strategies and methods are most effective in developing competency? ([Kim, 2015](#)).

4.2.4. Evaluation of training effectiveness

The schools will need to evaluate the effectiveness of their training programs to ensure that they are achieving their intended outcomes. This may involve assessing or evaluating employee performance before and after training.

4.2.5. Integration with performance management

A CBT system should be integrated with the University of Zambia's performance management system to ensure that employees are being evaluated on the competencies that are relevant to their roles. This will help to identify areas where further training may be needed.

4.2.6. Ongoing support and development

Finally, the schools must provide their employees with ongoing support and development opportunities to ensure they continue developing their skills and competencies over time ([Watson, 1990](#)).

4.3. Implication of the design of courses for a structured competency-based curriculum

From the preceding, it is clear that competency-based training (CBT) requires more planning and management than a traditional training system. Competency-based training (CBT) requires a more structured and intentional approach to planning and management than traditional education ([Fink and Fink, 2013](#)). The following must be observed when designing courses for a structured doctoral curriculum:

4.3.1. Clear learning outcomes

In CBT, learning outcomes are clearly defined in terms of skills and competencies that the learner is expected to acquire. This requires careful planning and alignment between the learning objectives, assessment strategies, and instructional methods. This means that course development in the curricula should take a backward design approach to ensure mastery of skills in the competency framework instead of a content-centered approach. Backward design, or backward planning, is an instructional design process that involves starting with the desired learning outcomes and working backward to design the curriculum, instructional activities, and assessments to help students achieve those outcomes ([Bowen, 2017](#)). A content-centered approach to instructional design focuses primarily on the content or subject matter that needs to be taught with little attention to what students might learn beyond content knowledge ([Fink, 2005](#)).

4.3.2. Personalized learning

CBT is designed to meet the individual needs of learners, which means that instruction must be tailored to each student's strengths, weaknesses, and learning preferences. This requires ongoing progress monitoring and frequent adjustments to instruction ([Watson, 1990](#)).

4.3.3. Assessment and feedback

CBT places a strong emphasis on assessment and feedback, which requires careful planning and management to ensure that assessments are aligned with learning outcomes and that feedback is timely, specific, and actionable. We encourage the use of forward-looking assessment with a procedure that will allow frequent, immediate, discriminating (based on clear criteria and standards) and lovingly (empathetically) delivered as guided by [Fink \(2005\)](#).

The curriculum framework we developed also guided the revision of postgraduate guidelines. Then to facilitate the smooth delivery of a competency-based PhD curriculum, we developed the postgraduate school handbook and logbooks.

4.4. Opportunities should this doctoral training model be well implemented

Implementing competency-based doctoral training presents several opportunities, which include:

4.4.1. Improving innovation and commercialization of research output

Due to a lack of a guided approach, improving innovation and commercialization of research is currently missing in most doctoral graduates, mostly in developing countries ([Cloete et al., 2016](#); [Fredua-Kwarteng, 2023](#)). Innovation from research is the process of taking knowledge, discoveries, and ideas generated from research activities and transforming them into new or improved products, services, or processes that have practical applications and create value for society. Research can lead to new technologies, treatments, and products that can transform industries, create new businesses, and improve people's lives ([Fredua-Kwarteng, 2023](#)). Doctoral candidates should be given innovation skills and research outputs to achieve this.

4.4.2. Improving the quality of supervision and research output

Publication output from research in a traditional PhD training model has been more on the thesis, with doctoral graduates failing to publish their work due to poor quality of supervision and a lack of scientific writing and communication skills ([Cloete et al., 2016](#)). The competency-based model provides an opportunity to increase publication outputs in reputable peer-reviewed journals to generate and disseminate knowledge for national development ([Waruru, 2022](#); [Fredua-Kwarteng, 2023](#)).

4.4.3. Obtaining skills from anywhere in the world through online platforms

Doctoral candidates can obtain skills from online programs anywhere in the world, thus improving networking with highly skilled individuals from the diaspora and better employment opportunities. Many universities now offer online doctoral programs that are competency-based. These programs allow students to complete coursework and assessments from anywhere worldwide on their own schedule. Students can earn certifications in specific competencies from anywhere and transfer credit into their doctoral program.

4.4.4. Improving linkages with industry

This model of doctoral training would improve linkages with industry and funding for research from the government and private sector. The graduate will also obtain practical skills in grant writing through guided mentorship. In addition, professional doctorates will be more attractive to those candidates with more interest in industry than academia and output of such will add more value and evidence base for industry problem-solving.

5. Conclusions and recommendations

In this paper, we presented lessons from the practice of a collaborative, iterative, and participatory process using several workshops, physical and virtual meetings, and email communication, which we used to develop and adopt a doctoral competency-based curriculum framework to transform PhD training at the UNZA. The steps followed in the doctoral curriculum framework included: Planning, competency framework development, mapping competencies to courses, course structure development, competence assessment framework, and credit value determination. We argue that a traditional unstructured apprenticeship way of PhD training does not give graduates the requisite industry-driven competencies that will lead to innovation and commercialization of research and development. We urge universities to start a conversation towards competency-based doctoral training and improve on this approach. We also recommend the nationalization of competency-based doctoral training through Higher Education Regulatory Authorities and relevant policy making bodies beyond the University of Zambia.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

Ethics statement

Ethical approval was not required for the studies involving human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in the studies was not required from the participants in accordance with the national legislation and the institutional requirements.

Author contributions

CM: conceptualization, involvement in workshops, generation of information, facilitation of workshops, development of a curriculum framework, and manuscript development. JS, JM, SM, and GK: involvement in workshops, generation of information, facilitation of workshops, development of a curriculum framework, and manuscript development. MM, MS, AP, WM, MHM, DH, KN, WN, PK-M, and

BH'o: involvement in workshops, development of a curriculum framework, and manuscript development. MH: development of Manuscript and provision of workspace and internet. ES, BH'o, and JM: funding workshops, information generation, and manuscript development. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2023.1224075/full#supplementary-material>

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