View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by International Development Research Centre: IDRC Digital Library

LEARNING WHAT WORKS: KNOWLEDGE EXCHANGE AND NETWORKING AMONG THE SCIENCE SYSTEM ACTORS IN SUB-SAHARAN AFRICA

Ozor Nicholas;Tom Kwanya;Ozor Gloria Nwandu;

;

© 2020, ACTS

This work is licensed under the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/legalcode), which permits unrestricted use, distribution, and reproduction, provided the original work is properly credited.

IDRC Grant: 108460-001-Networking Africa's science granting councils

Learning what works: knowledge exchange and networking among the science system actors in sub-Saharan Africa

Nicholas Ozor[1] nozor@atpsnet.org
Tom Kwanya[2] tom.kwanya@gmail.com
Gloria Nwandu Ozor[2, 3] glosunny2005@gmail.com

African Technology Policy Studies Network (ATPS), Nairobi, Kenya[1]
Technical University of Kenya[2]
Department of English and Literary Studies, University of Nigeria, Nsukka[3]

Nicholas Ozor holds a B. Agric. (Nig., First Class Honours); MSc, Agricultural Administration (Nig., Distinction) Ph.D, International and Rural Development and Agricultural Extension (Reading, UK and Nigeria respectively). He is the Executive Director of the African Technology Policy Studies Network (ATPS) Nairobi, Kenya, a transdisciplinary network of researchers, policymakers, private sector actors, and civil society actors promoting the generation, dissemination, use and mastery of science, technology and innovations (STI) for African development with coverage in 30 countries. He was formerly a senior lecturer in the Department of Agricultural Extension, University of Nigeria, Nsukka. Dr Ozor leads many internationally funded research projects bordering on STI. He is a member of many professional organizations and has published over 100 articles in reputable international journals, book chapters and other multimedia. Dr Ozor has raised over US$50 million in grants to support development work in Africa. He sits on the boards of many international bodies including UNESCO. His key skills include: fundraising; programme development and implementation; core research, teaching and community development; network building; capacity building and training; policy analysis and advocacy; knowledge valorization; communication and outreach; and leadership and mentorship goals, among others.

Tom Kwanya is an associate professor in the Department of Information and Knowledge Management at the Technical University of Kenya. He is currently also serving as the Director of the School of Information and Communication Studies. Prior to joining academics fulltime in 2013, he worked as a consultant on public information and knowledge management. He has authored several refereed journal articles, book chapters and conference papers. He has also edited two books and authored two monographs. His current research interests include organizational knowledge management, indigenous knowledge management, technology in information and knowledge centres, big data, and Internet of Things.

Gloria Nwandu Ozor is a lecturer in the Department of English and Literary Studies at the University of Nigeria, Nsukka. She is currently a postdoctoral fellow in the Department of Language and Communication Studies at The Technical University of Kenya. She obtained her Ph.D. in Literature from the University of Nairobi in 2018. Most of her works have been on how culture enhances social interaction and community development. Dr Ozor also examines how technology influences contemporary cultural performances for gender inclusivity. She is very passionate about studies that deal with gender inclusivity and community development for the improvement and sustainability of humanity and its environments.

Abstract

Knowledge exchange and networking (KEN) is a process which brings together researchers, users of research and wider public and private groups, communities and entrepreneurial individuals to exchange ideas, evidence and expertise. KEN is about developing mutually beneficial partnerships to support innovation and find solutions to the most pressing global challenges. Done effectively, it allows all participants to add value and impact to new ideas through engagement and collaboration. Ultimately, KEN has the capacity to drive transformational impact and enhance the societal application and benefits of African research. This chapter explores key concepts of and mechanisms for KEN, and identifies the mechanisms which work most effectively in an African context with particular focus on the science granting councils (SGCs) and other science system actors in sub-Saharan Africa (SSA). This chapter reviews and recommends good practices for sustaining KEN in order to co-create, share, and domesticate knowledge and its products among the target beneficiaries. It further explores the opportunities for embedding and sustaining networks to support knowledge exchange within the science system. The chapter identifies the benefits and challenges of KEN with a view to providing sustainable solutions to Africa's science system. The chapter finally draws practical lessons from the Science Granting Councils Initiative in sub-Saharan Africa (SGCI) to embellish how KEN has enhanced uptake, capacities and capabilities among the SGCs and other science system actors in SSA.

Key messages

- Knowledge exchange and networking (KEN) has the capacity to drive transformational impacts in societies through engagement and collaboration efforts that are mutually beneficial.
- The Science Granting Councils Initiative (SGCI) presents a unique platform in Africa, by African and for Africa in generating, sharing, learning and utilizing good practices, innovations, experiences and ideas emanating from science, technology and innovation (STI) endeavours.
- Various KEN mechanisms exist; however, it is important for individuals and organizations to undertake situational analyses to assess gaps and goals to be able to deploy appropriate mixes of KEN mechanisms to ensure efficiency, effectiveness and value for money.
- KEN reduces stagnating and knowledge production costs and hence facilitates knowledge improvements and innovation that solves societal challenges. In other words, outputs from KEN are cheaper and are of higher quality compared to individual efforts.

Introduction

Science, Technology and Innovation (STI) is recognized as a key driver of socio-economic development by enhancing national industrial productivity and competitiveness (Oyelaran-Oyeyinka, et al., 2018). Iizuka, Mawoko and Gault (2015) explain that STI activities in Africa were initially influenced by the Science and Technology Consolidated Plan of Action (CPA) which was endorsed in 2005 by the African Ministerial Council on Science and Technology (AMCOST) and adopted in 2007 by the Heads of State and Government. The CPA had three pillars, namely, technological innovation, knowledge production, and capacity building. After seven years of implementing the CPA, the African Union (AU), in recognition of the pivotal place of STI in socio-economic development, developed and adopted the 10-year Science, Technology, and Innovation Strategy for Africa (STISA-2024). According to the AU (2014), STISA is aimed at accelerating the development of human capital, innovation, industrialization, entrepreneurship and value addition as a means of facilitating social transformation, thereby enhancing the economic competitiveness of the continent.

Although Marcelle, Daniels and Whisgary (2014) acknowledge that Africa is steadily embracing STI to provide a platform for socio-economic development, they argue that responses to STISA have been insufficient, uncoordinated and may not be providing the ideal level of constructive engagements deserving of such a policy document with continental implications. They suggest that there is great need for a platform of sustained research and exploration on these issues. Despite its challenges, STISA demonstrates AU's commitment to mainstream STI in development. It also highlights the priority STI areas of focus at both the national and regional levels. Marcelle, Daniels and Whisgary (2014) suggest that for STISA to succeed optimally, there is need for: a robust research programme that effectively examines, identifies and conceptualises the innovation ecosystems, landscape and institutions (formal and informal) upon which the strategy can flourish; active and sustained commitment and engagement from African leaders and nations; a clear approach to soliciting, utilizing and managing inputs from industry and actual innovation performers; investigating the processes of learning, knowledge circulation and capability building (individual, organizational and technological) that are necessary to drive the strategy; and sustained investment in innovation activities across the continent.

Many actors contribute to the development and mainstreaming of STI in socio-economic development in sub-Saharan Africa (SSA). Among these players are science system actors. Hessels (2013) argues that science system actors are individuals or organizations which coordinate or contribute to the activities within a science system. Such actors may be grant makers, regulators or direct researchers. Datta (2018) adds that such actors may be drawn from the public (government), private or development sectors of an economy. Examples of science system actors include donor agencies, universities and other research institutions, private sector companies (industry), science granting councils (SGCs) as well as individual researchers and beneficiaries. Science system actors may operate at local (national), regional and international levels. Oyeyinka, et al. (2018) argue that the mandate of science system actors is not necessarily on science, technology and innovation alone. The actors complement each other through resources and ideas, thereby sustaining an ecological balance in the science system. Science system actors participate in collaborative projects, infrastructure development, capacity strengthening on STI, as well as the formulation of requisite policy and legal frameworks which facilitate the mainstreaming of STI in socio-economic development.

Science system actors in SSA generate a vast collection of knowledge products from their activities. Explicit (documented) knowledge generated from these activities includes good practice guidelines, standard operating procedures, templates, toolkits, new methodology and approaches, working papers, policy briefs, journal articles, and reports of commissioned studies. Tacit (non-documented) knowledge emanating from the activities includes ideas, experiences, institutional memory, institutional culture, instinct and intuition. Other knowledge products generated include video documentaries, photo albums and newspaper publications. Under its theme on enhancing networking and collaborations among the SGCs and with other actors in the innovation system, the Science Granting Councils Initiative (SGCI) commissions topical papers which inform Masterclass sessions held annually. These commissioned papers have resulted in the publication of policy briefs, research papers and journal articles.

It has been observed that science system actors operate in isolation and do not have comprehensive mechanisms for sharing the knowledge that different actors generate (Oyeyinka, et al., 2018). According to Parinov and Neylon (2011), science system actors are now under more pressure not only to measure but also to demonstrate the impact of their work than before. Science system actors can leverage and demonstrate the impact of their activities as far as STI is concerned through effective learning and sharing of their knowledge. This chapter explores key concepts of, and mechanisms for, knowledge exchange and networking (KEN) and identifies the mechanisms which work most effectively in an African context with particular focus on the SGCs and other science system actors in Africa. The chapter further reviews and recommends good practices for sustaining KEN in order to co-create, share, and domesticate knowledge and its products among the target beneficiaries. It further explores the opportunities for embedding and sustaining networks to support knowledge exchange within the science system. The chapter also identifies the benefits and challenges for KEN with a view to providing sustainable solutions to Africa's science system. The chapter also draws practical lessons from the SGCI to embellish how KEN has enhanced uptake, capacities and capabilities among the SGCs and other science system actors in SSA.

Key knowledge exchange and networking concepts

This section describes key KEN concepts. Some of the concepts defined include knowledge, knowledge exchange, knowledge networking and KEN.

What is knowledge?

The understanding of what constitutes knowledge is as diverse as the number of people considering it. Therefore, knowledge is perceived as being polysemic with the meaning adopted being determined by the context and purpose for which it is being attached. Sharp (2007) argues that knowledge is difficult to define because it is multifaceted, dynamic and contextual. According to Davenport and Prusak (1998), knowledge is a fluid mix of framed experiences, values, contextual information and expert insights which provide a framework for evaluating and integrating new experiences and information. Nonaka, Toyama and Nagata (2000) define knowledge as a dynamic human process of justifying personal belief towards the truth. Sharp (2007) perceives knowledge as the integration and reuse of ideas, experience, skills, intuition and lessons learned that influence how people solve problems and make decisions, as well as the way they work to continually create tangible outcomes of brand value and business worth.

Knowledge can also be defined as a progression of data and information. Theirauf (1999) defines data as the unstructured collection of facts and figures. Liew (2007) argues that data is basic, unrefined and unfiltered symbols and signals. He explains that symbols may consist of text, numbers, diagrams or images, while signals may include sensory readings of light, sound, smell, taste or touch. When data is organized and processed, it becomes information. Alexander (2002) explains that some of the processes that transform data into information include classifying, cleaning, interpreting, linking, sorting or summarising of captured data. Introna (1992) explains that the transformation of data to information may also include putting it into context because information is historical, contextual and perspectual. It is moulded by life experience to provide understanding. Thus, data can be perceived as the raw material which is processed to generate information. Bellinger, Castro and Mills (2004) explain that information is processed from data so as to provide answers to “who”, “what”, “where” and “when” questions. They suggest that knowledge is the appropriate collection and application of information in a manner that makes it possible to answer the questions “how” and “why”. Therefore, knowledge is not just a mere collection of information but also involves the cognitive analysis of the same to correctly answer the “how” and “why” questions. In other words, knowledge is the ability to apply information appropriately to understand, attend to or explain phenomena. Ackoff (1999) argues that wisdom is the capacity to understand which knowledge to apply in which situation. Thus, wisdom deals with values and the exercise of judgment.

In the context of this chapter, knowledge is perceived as: 1) facts held as true in specific contexts; 2) the ability to act or the capacity for effective action; 3) awareness, familiarity, acquaintance with an object, situation, phenomenon or event; 4) experience; 5) adverborial knowledge (knowledge of what and when); 6) skills, know-how (performatory knowledge); 7) cognition or recognition; 8) understanding (know-why); 9) a commodity, intellectual asset; and 10) the sum-total of what is known. All the above can be categorized into cognitive abilities which generally relate to the performance of tasks; acquaintance which relates to familiarity and personal experiences; and facts garnered from observation, perception or reason. Regardless of the category of meaning, knowledge and knowing are valuable for, and essential to, all forms of human endeavour.

Knowledge exchange

According to UNICEF (2015) knowledge exchange is the systematic process of sharing experiences, ideas, successes and challenges in order to support the performance of specific tasks within an organization or community. The main purpose of knowledge exchange is to connect practitioners to learn from one another. Sharing experiential knowledge leads to the discovery of new approaches, which fuels innovation as well as personal or institutional improvement.

London School of Economics and Political Science (2020) defines knowledge exchange as a two-way process which involves sharing knowledge, experience, ideas, evidence or expertise between parties in ways intended to be mutually beneficial. Knowledge exchange is contrasted with knowledge dissemination by emphasising that while the former concept utilizes two-way interactions, knowledge dissemination involves one-way approaches and media. Knowledge exchange provides a means of enhancing individual or organizational impact by increasing the visibility and accessibility of knowledge or knowledge products. Knowledge exchange goes beyond a mere exposition of knowledge to mutual learning of new skills, ideas or best practices. Knowledge exchange, in certain circumstances, involves collaborative identification and solving of specific problems. Therefore, knowledge exchange approaches, tools and results may vary from case to case.

Economic and Social Research Council (ESRC) (2020) argues that knowledge exchange efforts work best when they have been designed with specific objectives. Therefore, selecting knowledge exchange approaches strategically works better than merely imitating what other people or organizations have applied. Given that knowledge exchange is a collaborative process, it is imperative that a working relationship between the parties be established prior to starting the actual exchange.

Among science system actors, knowledge exchange involves the sharing of knowledge obtained through research and experience between researchers (or research institutions) and strategic publics in the system including direct beneficiaries, practitioners, policymakers as well as other stakeholders. Therefore, knowledge exchange is only one step in a more complex process of knowledge generation (or collection), organization, validation, learning, uptake and preservation. It is critical because it provides the means by which science system actors can influence society positively and stimulate (facilitate) socio-economic development. It is also a means through which science system actors learn from the communities they work with, thereby providing a feedback loop of seamless collaborative learning and uptake of knowledge. This is in recognition of the fact that although knowledge is deemed to originate from science system actors through research, the same needs to be validated and enriched through interaction with the community where it has been developed. Thus, the knowledge is enriched with diverse perspectives brought forth by the community through myriad forms of cross-fertilization of ideas (National Academy of Sciences, 1994). According to the World Bank (2017), knowledge exchange facilitates peer-to-peer learning which provides a powerful way to share, replicate and scale up what works when addressing societal challenges, adding that when done right, knowledge exchange can build the capacity, confidence, and conviction of individuals and groups to act.

Knowledge networking

Seufert, Von Krogh and Back (2004) define knowledge networking as bringing together a number of people, resources and relationships among them, in order to accumulate and use knowledge primarily by means of knowledge creation and transfer processes, for the purpose of creating value. Networking is a means of breaking barriers to knowledge exchange and learning. It enables the linking of knowledge islands and silos to facilitate effective creation and uptake of knowledge. According to Skyrme (2007), knowledge networks are enabled through behaviour such as trust, reciprocity, and mutual support; clear identification of a shared purpose; formation of teams and knowledge champions whose roles are clearly defined and accepted; frequent and appropriate communication; a culture of sharing; seamless knowledge management processes; and written or unwritten rules of engagement. Seufert, Von Krogh and Back (2004) argue that the openness and richness of networks foster a fertile environment for the creation of entirely new knowledge, while also accelerating the innovation rate. Knowledge networking is therefore perceived as the process of creating and sustaining knowledge networks. Owing to the dynamic nature of knowledge, knowledge networks are emergent.

Knowledge networks can involve individuals, teams and organizations (Mentzas, et al., 2001). According to Chatti, Jarke and Frosch-Wilke (2007), knowledge networking benefits from the social aspects of knowledge creation and learning. They emphasise the role of community building to leverage, create, sustain and share knowledge in a collaborative way, through participation, dialogue, discussion, observation and imitation. The typology of knowledge networks is diverse. While some are formal, others are less formal, or even totally informal. Some are large while others are small. Members of networks may belong to one or more networks at the same time. In some networks, they may be in the core while in others they may choose to remain in the periphery. Furthermore, some networks may be virtual (online) while others may be physical (offline).

Hustad (2004) argues that knowledge is created and shared through networks which he described as "communities of knowing". He further explains that the creation and sustenance of such networks have lately relied on ICT platforms. Citing the example of Ericsson, Hustad (2004) explains that many organizations have shifted from the "philosophy" of knowledge management to knowledge networking which facilitates people to share and reuse knowledge and experience and to locate specialists and initiatives in order to improve organizational performance. According to Plum and Hassink (2011), a large number of knowledge networks are created to solve specific practical problems.

In summary, it is important to note that knowledge, knowledge exchange and knowledge networking all fall under the broad area of knowledge system. Knowledge System (KS) comprises of an organized structure and dynamic process for: (a) generating and representing content, components, classes, or types of knowledge; that is (b) domain specific or characterised by domain-relevant features as defined by the user or consumer; (c) reinforced by a set of logical relationships that connect the content of knowledge to its value (utility); (d) enhanced by a set of iterative processes that enable the evolution, revision, adaptation, and advancement of knowledge; and (e) subject to criteria of relevance, reliability, and quality (GSSD, n.d.). A knowledge system will encompass the actors, their roles, the contexts and contents, and the existing linkages that make the system work. This system strengthens the KEN mechanisms.

Rationale

The process of developing knowledge either through a research procedure or informal means most times excludes outsiders from that knowledge production process. Irrespective of its origins, knowledge shapes decisions and implementations, while the learning that occurs through the knowledge production process influences future actions (Fazey, Fazey and Fazey, 2005). This means that if one is to generate a particular knowledge afresh each time, lots of human and material resources will be wasted because of the frequencies of doing similar things to produce similar results by different people all the time. If this was the case, the world would have been so stagnated that there would not be much progress, improvements and innovations. Imagine a world where any knowledge produced remained with the producer alone. Learning would have been impossible. It therefore becomes imperative to share knowledge generated, for others to learn from it, improve on it and probably produce more and better knowledge products. Consequently, the main rationale for knowledge exchange is to share information that could be useful in one way or another to the recipients of the information both at the short, medium and long term. Knowledge exchange provides the opportunity to connect people together so that they can share their work, discuss it, learn from each other, collaborate in it, co-produce and use the knowledge to improve and innovate on their own works and practices. Sharing knowledge, especially experiential knowledge, is a key ingredient in innovation and is essential to achieve continual learning from experience which can be applied to improve work (UNICEF, 2015).

When the people concerned with knowledge exchange come together, they form a network or network of networks, and are able to facilitate and foster mutually exclusive sharing of data, information, expertise and skills between and among themselves, implying that the actors have something to gain from the interactions in a knowledge exchange process. Knowledge exchange and networks therefore form the basis through which individuals, groups, organizations and other professional bodies come together to share ideas, co-generate and co-produce new ideas, implement it and use it for further production of knowledge that will be useful in providing solutions to the challenges facing mankind.

One such network is the SGCI in SSA. The Initiative aims to strengthen the capacities of the SGCs in SSA to support research and evidence-based policies that can contribute to economic and social development in the region. Specifically, the Initiative is strengthening the ability of the participating SGCs to: i) manage research; ii) design and monitor research programmes, and to formulate and implement policies based on the use of robust STI indicators; iii) support knowledge transfer to the private sector, and; iv) establish partnerships among the SGCs and with other science system actors. More effective SGCs are expected to strengthen national STI systems, and ultimately lead to nationally led research that contributes to development in the participating countries.

Knowledge exchange makes use of specific tools and approaches. These include tools for fostering in-person (face-to-face) exchange and tools that make use of virtual platforms for exchanging and sharing information. They also include platforms and software tools that enable online networking and knowledge sharing across geographic and organizational barriers, supporting communities of practice to grow, co-create solutions, share successes and key resources.

This chapter therefore aims to provide an understanding of the key concepts and mechanisms for achieving an effective KEN, especially among the science system actors in Africa. The chapter uses case examples to demonstrate how KEN can work in specific contexts in Africa while also drawing from the SGCI. It further explores the benefits and challenges to KEN and provides practical solutions and recommendations for implementing KEN in any science or related systems.

Approach

To achieve the above stated objectives, the authors employed multiple approaches to generate proven data and information required for writing this chapter. These include: i) desk studies where relevant published and grey literature on the subject matter were reviewed and compiled; ii) interviews and case study examples where information generated from practical examples on some KEN mechanisms were equally utilized; and iii) experiential learning from the SGCI masterclasses which were used to support the body of literature, interviews and case examples generated for the purposes of preparing this chapter.

Every year since 2016, delegates from 15 participating SGCs in 15 countries and other science system actors within Africa and beyond converge to interact and share knowledge, lessons and experiences from their respective countries under the SGCI. Data and information generated from these events were used to enrich the chapter with practical realities as well as contexts that will fit into African realities.

Mechanisms for knowledge exchange and networking

Organizations apply myriad mechanisms to facilitate KEN. The choice of a mechanism is determined by many factors including organizational mandate, vision and mission; organizational structure and culture; socio-economic and environmental factors in the community where the organization operates; as well as organizational knowledge capabilities and maturity levels. Some of the mechanisms that the science system actors can apply for KEN are discussed in this section.

Co-location and co-access to facilities

This is a KEN mechanism which facilitates the sharing of knowledge infrastructure such as laboratories, workshops, innovation hubs, ICT infrastructure for data storage and bandwidth, and office spaces. Co-location and co-access to facilities enables the pooling of physical resources for purposes of research and innovation. In this model of KEN, universities and research institutions can house start-ups, small and medium enterprises (SME) and innovators in a framework which enables the housing institutions not only to mentor the housed entities but also to help them reduce their overhead expenditure until they are able to stand on their own. This mechanism enables innovators to experiment with emerging ideas without having to worry about exorbitant overheads during their infancy stage. Co-location also enables small actors to easily access expertise within universities and other research institutions.

Several models of co-location and co-access to facilities exist in SSA. However, the most dominant are innovation and incubation hubs hosted by universities, research centres and technological companies. So successful have these been that they have together created a critical innovation landscape described as the "Silicon Savannah", a term used to describe the technology ecosystem in some African countries popular for producing fast growing social enterprises. Some of the successful hubs include Co-creation Hub (CcHUB) in Nigeria; iHub in Kenya; KLab in Rwanda; invoTECH and mLAB in South Africa; and Ghana Innovation Hub of Ghana, to mention but a few.

Collaborative research

Another mechanism for KEN is collaborative research. This is research conducted through the collective efforts of two or more individuals or institutions. Collaborative research may be conducted by members of two or more departments in an institution working together on a common project; a researcher from a private company working with researchers based in a university or research centre; and researchers from two or more institutions working on a research project of common interest. Collaborative research may also be considered from a disciplinary perspective. Therefore, research can be described as either unidisciplinary, multidisciplinary, interdisciplinary or transdisciplinary. In unidisciplinary research, all the collaborating researchers are from the same discipline while in multidisciplinary scenarios, the researchers are drawn from more than one discipline. Interdisciplinary collaborative research occurs when multiple researchers work from within their own disciplines but focus on solving a common problem. Transdisciplinary collaborative research occurs when researchers use a shared conceptual framework to address a research problem by involving even the target end-users in identifying the challenges and co-creating the solutions.

Currently, there is a strong drive towards collaborative research globally (Wray, 2002; Cummings and Kiesler, 2005).A number of research funding agencies now pay special attention to collaborative research proposals. The benefits of collaborative research include: ability to share and exchange resources; opportunities for the researchers to learn from each other; division of labour which ensures timely completion of research projects; specialization associated with collaborative research which enhances the quality of research outputs and outcomes; and credibility and validity of research projects, outputs and outcomes. Beaver (2004) argues that outputs from collaborative research projects are generally of a higher quality than those from individual (lone) researchers. Therefore, collaborative research products are more authoritative and stand a higher chance of being cited or applied. Jean-Louis and Lomas (2003) explain that people and organizations participate in collaborative research to: broaden the range in choices in defining research problems and designing methodologies; better interpret research findings; encourage greater use of research findings to solve problems and address issues; and stimulate change in the way researchers think, practitioners take action or society uses knowledge. Disadvantages of collaborative research revolve around conflicts among the research teams, donors or parent institutions; poor coordination of collaborative research work plans, which may result in delays in attaining research milestones; and difficulty in the attribution of intellectual property resulting from research projects (Davenport, Davies and Grimes, 1998; Sprunger, 2017).

Jean-Louis and Lomas (2003) argue that there seems to be a new spirit of cooperation between researchers in the production of scientific knowledge. They explain that there is new understanding that knowledge production in society is collaborative rather than monolithic. Researchers have come to understand that there are many aspects of knowledge which can only be effectively accommodated through collaboration between multiple researchers. This understanding has blurred the frontiers between individual actors in research and encouraged greater collaboration.

Co-design and co-delivery of programmes

Science system actors can also exchange knowledge through co-design and co-delivery of academic programmes. According to Martin, Stevens and Arbour (2017), co-design and co-delivery of programmes enables diverse stakeholders to participate in the design and delivery of programmes which meet their specific needs. In the context of KEN, academic institutions can work with other science system actors to identify knowledge gaps which they can bridge through collaboratively designed and delivered academic programmes. Such programmes may include undergraduate, postgraduate and short courses which are tailored to meet specific knowledge needs. A key tenet of the co-design and co-delivery approaches is that users, as 'experts' of their own experience, become central to the design and uptake process, thereby owning it.

Vargas and Venezia (2015) explain that co-design involves deciding on and designing together courses, curricular pathways, and support systems, as well as professional development opportunities and data platforms, that impact what and how people learn. They also explain that co-delivery is the sharing and coordinating of faculty and staff, facilities and other resources to carry out the co-designed learning experiences and supports. The key tenets of co-design and co-delivery of programmes include concepts such as participation, working together, influencing and being influenced, power sharing and clarity of purpose.

Svendsen and Laberge (2006) propose the concept of "co-creative" engagement process in which multiple stakeholders can network and co-create innovative solutions to complex challenges affecting them. These networks are aimed at building trust and mutual understanding to enable collective action. The success of co-creative processes is hinged on the relationship between the stakeholders in the community. Diverse views, backgrounds and interests of network members are seen as providing opportunities for creativity, innovation and learning.

The advantage of co-design and co-delivery of programmes lies in the fact that it fosters participatory approaches in meeting collective knowledge needs of a community of stakeholders (Jessup, et al, 2018). The use of this approach as a means of enhancing KEN benefits from the fact that the solutions proposed emanate from the perspectives of multiple stakeholders, thereby making them rich and optimized for each context. Solutions designed in this way are more likely to be acceptable to both providers and end users, and therefore adopted and sustained. Ward, et al. (2018) opines that for co-design and co-delivery approaches to succeed, the actors should be willing to work within the teams to meet shared goals; listen to, and consider, different perspectives and opinions; communicate clearly and regularly; make contributions readily and unreservedly towards solving the communal knowledge challenges; and forego personal benefits for the sake of the communal good of the network.

The co-design and co-delivery approach is an effective mechanism for fostering industry-academia partnerships that lead to the development of effective competency-based curricula and hands-on educational systems. Such partnerships have led to the training of highly skilled graduates that meet the needs of the industry and are able to support economic growth and development.

IP commercialization

Scientific and technological research and applications ordinarily result in intellectual property (IP) products through new creations or innovations. Some of the IP products can be developed further and commercialized to generate revenue for the scientists. Although scientists are creators of knowledge, they ordinarily lack business skills or infrastructure to sell their IP products. They can partner with SMEs or corporates to commercialize their products. Similarly, they can create start-up companies, commonly known as spinoffs or spinouts, to develop, produce and sell the IP products. IP owners may also license existing companies to produce or sell IP products under specific terms and conditions of engagement. Rasmussen (2008) explains that the IP commercialization model embraced by an entity depends on its needs, context and the IP product.

Commercialization is the process of bringing an IP product into the market for sale and exploitation. Markman, Siegel and Wright (2008) argue that IP commercialization enables private, public, and even non-profit organizations to mobilize their idle, unexploited, and underutilized discoveries, inventions and innovations into the open market. They explain further that increased IP commercialization has led to the emergence of new organizational forms and functions that promote research, knowledge and technology commercialization, such as technology transfer offices (within for-profit and non-profit organizations), science parks, incubators, and industry-university research centres. They add that for universities and public research institutions, the trend towards commercialization reflects pressures to maximise the social return on public investment in research and efforts to enhance self-sustenance.

IP commercialization is an elaborate process requiring legal as well as business product development and production skills. Universities interested in commercializing their IP products have created outfits which manage this process in ways which safeguard the interests of the university, the scientists, researchers and the society. Commercialization enables producers of knowledge to facilitate its application to make the world a better place. Thus, commercialization provides a means of validating scientific knowledge.

Communication and engagement

Science system actors can exchange knowledge through communication and engagement. Indeed communication is the means of exposing scientific knowledge to its potential users or brokers. Both verbal and non-verbal communication is invaluable in the dissemination and uptake of knowledge in the form of research products. One of the most common means of communicating research is through scholarly communication. This is a genre of communication which focuses on disseminating scientific knowledge through peer reviewed publications such as journal articles, conference papers, monographs, posters as well as theses and dissertations, among others. The distinguishing attribute of scholarly communication is the role of peer review as a means of quality control and assurance.

Scientific knowledge can also be disseminated through the mass media. This can be done through featured articles, opinion pieces as well as news items. The advantage of using the mass media for scientific communication is that it reaches a large audience. Furthermore, mass media products are simplified and can appeal to many people, going beyond the academia. The mass media provides a means of reaching out to potential beneficiaries of scientific knowledge as well as policy formulators and implementers. The mass media also brings benefits associated with multimedia capability.

Science system actors can also establish communication facilities such as libraries and resource centres through which knowledge is collected, collated, organized, stored and perpetuated. Using emerging technologies exemplified by the Internet, such facilities can increase the reach and longevity of knowledge products. In the context of open access publishing, such facilities can enhance access to knowledge products through creative commons and federated collection development frameworks.

Knowledge may also be shared through engagement which entails the use of interaction platforms such as events to co-create, validate or apply knowledge by a strategic group. Engagement also implies the creation and use of networks and alliances to mobilize resources for knowledge creation, sharing and use. Science system actors can use public relations, lobbying, advocacy and activism to generate, collect and promote access to knowledge products.

Communication and engagement may also include knowledge sharing techniques such as communities of practice; knowledge café; storytelling; drama, music and theatre; indigenous knowledge and practices; public information; best practices; demonstrations; protocols; manuals; standard operation procedures; topical tables; conferences; mind mapping; webinars; residencies; apprenticeship; and job shadowing, among other techniques.

Continuing professional education

This is the process of continuously developing the important skills of professionals in a discipline. It is used as a means of keeping the professionals abreast with the developments in the discipline and bridging skill gaps encountered during practice. Continuing professional development is achieved largely through formal training, professional registration examinations, short courses, and other professional events. Some professional associations have set mandatory thresholds for professional development and require their members to attain a set number of scores annually by taking short courses recognized by the associations.

Continuous professional education provides a framework for professionals to update their skills as a means of coping with emerging demands of their practice (Lessing and Dewitt, 2007). Continuous professional development programmes are specific and specialized. This enables the participants to continue building on their skills without having to take a long-term post-graduation training (Ryan, 2003). It also facilitates re-certification of professionals in fast-changing fields such as medicine (Wasserman, Kimball and Duffy, 2000); ensures the retention of professionals in the discipline by keeping them interested in the practice (Opfer and Pedder, 2010); as well as builds the capacity of the professionals on emerging tools and technologies (Marshall, Punys and Sykes, 2008).

Consultancy

This is a practice where experts offer professional advice or service to other parties, normally at a fee. Ideally, consultancy is a form of knowledge exchange where a professional with expert knowledge shares knowledge with another party. Consultants provide expert knowledge in the form of recommendations, advice, opinions or implementation of specific projects. Thus, consultants are specialists hired to perform a specific task for a specific period of time under specific terms by individuals or organizations.

Consultancies enable experts to share their knowledge. Science system actors can use consultancies as capacity building opportunities through which experts expose their knowledge and also strengthen the capacity of the clients. Given the costs associated with employing experts fully, consultancy provides an affordable option of benefiting from them without having to keep them in fulltime employment. The best way to benefit from the skills of consultants is to build a training aspect to all consultancies which enables the organizations to acquire some knowledge from the experts. This may be done by ensuring the consultants work closely with client's staff. For consultancies to work effectively for them, science system actors should ensure that they select consultants carefully. Many people masquerading as consultants are quacks only interested in gaining unfairly from organizations which are desperate for expert services.

The SGCI Masterclass

The SGCI Masterclass serve as a one-stop-shop for the presentation, learning, exchange, sharing and documentation of stories of change on topical science, technology and innovation (STI) issues emanating from the participating 15 SGCs in SSA. The main aim of the masterclass is to present to the science system actors, a theme bordering around STI issues by a qualified professional in the chosen area of importance. The delegates are usually drawn from the 15 participating SGCs in the 15 countries and other science system actors from Africa and the rest of the world. The masterclass paper is intended to provide insightful and critical knowledge, information, experiences and case studies capable of stimulating discussions and debates during and after the masterclass. Discussions around the paper enable the SGCs to learn good practices from across the world and be able to use the outcomes from the masterclass to initiate policy-oriented interventions in their respective countries. We have offered below brief descriptions on how the SGCI masterclass has been highly successful as a KEN mechanism:

How the theme of the masterclass paper is selected: The theme of the masterclass paper is usually agreed upon by a range of actors within the SGCI. At first, the Collaborating Technical Agency (CTA) responsible for convening the SGCs reaches out to the participating 15 SGCs who are the primary beneficiaries of the Initiative, to identify themes of their choice that will be relevant in achieving their mandates as councils. These themes are collated, ranked and shared with the Initiative's Management Team (IMT) for approval. Once approved, the chosen theme is communicated back to the SGCs and arrangements for commissioning qualified authors who will write the paper will commence.

How the author(s) of the masterclass paper is selected: As soon as approval for the theme of the masterclass paper is received from the IMT, the CTA develops a concept note on the theme as well as the Terms of Reference (ToR) for the potential author(s) of the masterclass paper, which are then used to seek for Expressions of Interest (EoI) from potential authors. An advert is then placed by the CTA and distributed widely among the STI community in Africa and beyond. Known authors with suitable qualifications and experience on the chosen theme are also encouraged to submit applications. Applications are reviewed based on pre-set criteria by at least three experts and their scores ranked according to their performances and then submitted to the IMT for their final review and approvals. Usually the pre-set criteria are based on team composition, qualifications and experience, annotated table of content submitted, and work plan for the writing of the paper. In liaison with the IMT, the CTA appoints the preferred author(s) with clearly set out timelines and deliverables.

How the masterclass paper is reviewed: The CTA and IMT jointly review the draft paper submitted by the authors at least twice before the final paper is presented during the masterclass. The first draft of the paper is usually reviewed in-depth to ensure that the paper aligns with the intended objectives and research questions posed in the concept note and ToR. All comments and inputs on the drafts of the paper are collated by the CTA and sent to the authors for revisions on the paper. Once the paper is certified satisfactory by the CTA and IMT, the CTA now distributes the final draft masterclass paper to all the delegates to that year's masterclass (otherwise called Annual Forum) to enable them read the paper and prepare their comments, observations, interventions and questions ahead of the masterclass.

How the masterclass paper is presented: The author(s) of the masterclass paper prepares the presentation for the masterclass which is reviewed by the CTA ahead of the presentation. The agreed final paper is presented by the lead author and supported by another co-author (sometimes). The SGCI masterclass is also designed in such a way that other professionals provide perspectives to the paper presented. In these perspectives, the professionals try to contextualise and adapt the paper to the practical realities of the science system in Africa. Thereafter, some selected heads of research councils (HORCs) who would have been pre-informed of their roles provide their perspectives on the paper, drawing from their own countries' experiences. This helps to provide lessons and good practices on the subject that could be of relevance to other countries present. An open discussion on the paper follows with all participating delegates entitled to contribute. All the presentations and discussions are documented and used to enrich the final masterclass paper, produce the proceedings of the masterclass, and may be used to set the stage for the next theme of another masterclass. A session is always created during the masterclass event for the SGCs to share stories of change and knowledge uptake from the previous masterclasses. Box 1 shows examples of knowledge uptake from the SGCs.

How the masterclass paper is published: The masterclass paper is revised by integrating the inputs, comments and observations received during the masterclass. From the revised paper, three key knowledge products are usually produced. They include research paper, policy briefs and journal articles. These knowledge products target different audiences including researchers, policymakers and practitioners. The publications from the SGCI have helped to create wide visibility about the Initiative and greater understanding of the aims and objectives of the Initiative in supporting research and evidence-based policies that can contribute to economic and social development in Africa.

Box 1: Examples of knowledge uptake from the SGCI Masterclasses

1. In Uganda, a National Research and Innovation Support Framework was established to augment R&D funding towards the recommended regional level (1% of GDP) and consciously finance scientific innovation. The masterclass paper on 'New Approaches to Funding Research and Innovation in Africa' contributed to this outcome.
2. In Uganda, the Uganda National Council for Science and Technology (UNCST) has revised the national research guidelines to include windows of support for social innovations; platforms for academia-industry research collaboration and for greater alignment with regional and global development strategies. The Council is also revising its strategy and approaches to stakeholder engagement in ways that enable co-investment, co-creation and incentivising multi-stakeholder platforms on various aspects of STI development. The masterclass paper on 'Towards Effective Public-Private Partnership in Research and Innovation' contributed to these outcomes.
3. In Mozambique, the National Research Fund (FNI) has commenced discussions with relevant agencies in the country on how to address the funding limitation for research and innovation development and the need for the establishment of a national research agenda in the country. This is an outcome from the masterclass paper on 'New Approaches to Funding Research and Innovation in Africa'.
4. Again in Mozambique, the FNI has reinforced the establishment of partnerships and exchange of experience with the SGCs in the region. They have started in-country actions to bring the private sector into the research agenda and have signed a memorandum of understanding (MoU) with the in-country national representative of the private sector to start a partnership relation for research and innovation. These are outcomes with contributions from the masterclass paper on 'Towards Effective Public-Private Partnership in Research and Innovation'.
5. In Malawi, the National Commission for Science and Technology (NCST) has fostered partnerships with other STI system actors especially with the higher education sub-sector and held for the first time, a major national meeting on STI in the country. The masterclass paper on 'Towards Effective Public-Private Partnership in Research and Innovation' contributed to this outcome.
6. In Senegal, the Research and Innovation Directorate has undertaken actions in the country to promote public-private partnership, e.g. the introduction of Board of Directors in universities and opening up of universities and research institutions for enterprise development, among others. The masterclass paper on Public-Private Partnership contributed to this outcome.
7. In Botswana, the Department of Research Science and Technology (DRST) is reviewing effective and sustainable approaches for boosting research funds in the country. This came after the lessons learnt from the masterclass paper on 'New Approaches to Funding Research and Innovation in Africa'. The Department is also working with other partners to develop the 'National Private Engagement Strategy' based on lessons learnt from the Public-Private Partnership masterclass paper.

Benefits and challenges of knowledge exchange and networking

This section presents the benefits and challenges of knowledge exchange and networks with a view to providing insights on when, why, and where it can be applied in a science system so as to achieve the key objective of learning lessons from knowledge for development.

Benefits of knowledge exchange and networking

The benefits of KEN as a means of enhancing knowledge creation, organization, sharing, validation and perpetuation are diverse. They include, but are not limited to, the following:

Process benefits: Effective KEN can result in myriad process benefits for science system actors. Some of these benefits include streamlined processes; enhanced efficiency; time-saving; reduction of process errors; increased process transparency; reduced redundancies; and reduced transaction costs. Essentially, KEN results in optimized processes which are efficient and cost-effective.

Employee benefits: In the age of knowledge workers, employees are a valuable resource to the organization, more than capital and physical resources. It is in the interest of progressive science system actors to ensure that they attract, motivate and retain the best possible human capital. KEN is one of the strategies through which this can be achieved. This is because when done effectively, KEN leads to increased organizational learning; enhanced staff motivation; improved personal knowledge-base; increased staff retention; improved teamwork; enhanced staff participation; and shorter staff on-boarding time.

Customer benefits: Science system actors largely exist to meet the needs of specific clientele or publics. Without these publics, the organizations may cease to exist – at least not as they are currently established. Therefore, meeting customer expectations and needs is a critical determinant of organizational survival. KEN can enable organizations to attain: increased understanding of customers; improved customer satisfaction; better communication with customers; improved quality of services and products; enhanced customer retention; reduced turnaround time; and increased collaboration with customers.

Financial benefits: Organizations require financial resources to operate. Nothing much can be achieved without this resource. Ironically, it is one of the rarest resources for science system actors in SSA. KEN can generate varied financial benefits for the organizations. These include better analysis and mitigation of risks; increased financial turnover; increased market share; optimized marketing strategies; reduced marketing costs; reduced operational costs; and improved decision making.

Innovation benefits: Science system actors compete for resources, namely donors, collaborators, infrastructure and staff. The capacity of the organizations to survive and thrive in the increasingly competitive environment depends on their level of innovation. KEN can lead to improved research and development; increased generation of new knowledge; better application of technologies; development of new products and services; development of new business segments; enhanced quality of services and products; and improved organizational continuity.

Other benefits: Several other benefits can be drawn from effective KEN. These include increased productivity; enhanced coordination and resource pooling; prompt solution of problems; grounded knowledge and learning culture; better management of change; increased flexibility and adaptability; enhanced competitiveness; development and application of standards; improved reputation and relationships; reduced personnel requirements; increased organizational synergy; enhanced knowledge sharing and diffusion; visible use of organizational resources; and emergence of positive organizational values, among others.

Challenges of knowledge exchange and networking

The following challenges are likely to hinder effective KEN among science system actors in SSA:

Inadequate resources: Most science system actors in SSA lack adequate financial, human and physical resources to facilitate effective KEN. They largely rely on inadequate budgets and donations from philanthropic organizations and individuals outside the region.

Knowledge hoarding: Many bearers of knowledge are not willing to share their knowledge. Many factors lead to this. However, the most dominant cause is insecurity when knowledge owners feel that by exposing their knowledge, they would lose the power associated with it. Thus, it may result in job or influence losses.

Poor leadership: KEN initiatives need to be designed and promoted by knowledge champions and brokers. Many science system actors in SSA lack experienced knowledge champions and brokers. This hinders their vision and leads to ineffective KEN initiatives.

Culture of imitation: Many science system actors in SSA fall to the temptation of copying other organizations, some of which operate in different contexts. This results in stunted knowledge growth. Copying what is already being done limits an organization's competitive advantage.

Lone ranger syndrome: Some science system actors are secretive in their efforts to remain competitive. Therefore, they keep their plans and resources under wraps, thereby limiting their capacity to benefit from their communities. There is power in numbers. Organizations which work in isolation cannot tap the benefits derived from collaborative networks.

Inadequate frameworks for collaboration: Most countries lack policy and legal frameworks that stimulate effective KEN. Science system actors may be willing to network and exchange knowledge but may be hindered in the process by loopholes in existing policies and legislation.

Key policy recommendations for sustaining knowledge exchange and networking

The following key policy recommendations are proffered to enhance effective KEN in Africa:

1. **Strengthen systemic coordination and learning among the science system actors**: The current linkage system and coordination between and among the science system actors in Africa is relatively weak. This is exacerbated by low financial investments, institutional failures, poor public-private partnerships and low capabilities in the science system. There is therefore an urgent need for responsible government ministries, departments and agencies (MDAs) such as the SGCs to make deliberate efforts to coordinate and establish mechanisms for sectoral interactions across public and private entities to share knowledge, ideas and innovations that will optimize government efforts in the knowledge production, commercialization and utilization continuum. All the critical actors in the science system must work together and offer synergies and complementarities to one another so as to sustain socio-economic development at national, regional and continental levels.

2. **Establish open science policies and frameworks:** To increase the opportunity for knowledge sharing and exchange among the science system actors, there is need for African governments to embrace and establish open science policies and frameworks that will compel knowledge generators to easily share and exchange their knowledge in the science system and hence prevent knowledge hoarding. This applies mostly to knowledge that has been generated using public funds. Open Science (OS) is defined as "science carried out and communicated in a manner which allows others to contribute, collaborate and add to the research effort, with all kinds of data, results and protocols made freely available at different stages of the research process" (Di Giorgio, 2017). Thus, OS connotes the opening up of the entire research process from agenda-setting, data generation and analysis, to dissemination and use with the aid of various emerging digital and physical platforms and tools. In this context therefore, OS is viewed as "transparent and accessible knowledge that is shared and developed through collaborative networks" (Vicente-Saez, 2018) and is guided by a number of principles, including open data, open access, open innovation, open source, open methodology, citizen science, and open peer-review, among others (Vetro, et al., 2016).

3. **Strengthen state and non-state institutions and networks that generate and utilize knowledge**: For knowledge to be shared or exchanged, it has to first of all be generated. It therefore becomes imperative for both state and non-state institutions involved in knowledge generation to be strengthened with adequate resources to effectively generate robust knowledge that could be shared among the various actors in the science system. Such resources will include human capital, financial investments, infrastructure and incentive structures, among others. Most importantly, strengthening public-private partnerships in knowledge generation, dissemination and utilization makes it possible for an inclusive and sustained production and utilization of knowledge. Existing networks and platforms that share knowledge around science, technology and innovation in Africa should also be supported to continually create platforms for sharing and exchanging knowledge on the continent. An example of such institutions is the African Technology Policy Studies Network (ATPS) which has been rated for many years as the most networked think tank in Africa (McGann, 2020).

Conclusion

Knowledge is now the most important organizational asset ranking far above land, capital and labour. Organizations in the modern age thrive or fail based on their capacity to create or access valuable knowledge. Many organizations, in their efforts to leverage their intellectual assets have focused on individual, lone-range projects without realizing that knowledge management is a social activity which works better in collaborative environments. Knowledge is one of the few assets that grow exponentially when shared. Organizations which work in STI environments rely on knowledge creation and sharing to thrive. Therefore, they need to embrace the philosophy of co-creation, sharing and use of knowledge. One of the strategies that can facilitate this is KEN.

This chapter has delved into the details of what KEN means and how it works; the different mechanisms of KEN that can be employed; its benefits for science system actors in SSA; the challenges likely to hinder its effective execution and how the same can be mitigated as well as key policy recommendations for effective KEN. Whereas we acknowledge that this chapter cannot have covered all the issues pertinent to KEN among science system actors in SSA, it adds to the many voices out there discussing this important issue. It is, therefore, a contribution to the ongoing discourse and body of knowledge on this important theme.

Acknowledgement

The authors wish to acknowledge and appreciate the RECIRCULATE Programme of the Lancaster University, United Kingdom for offering training and residency opportunities to them. This has greatly enriched their wealth of knowledge on the subject matter.

References

Ackoff, R. L., 1999. *Ackoff's Best*. New York: John Wiley & Sons.

African Union, 2014. Science, technology and innovation strategy for Africa 2024 (STISA-2024). *Science & Technology, African Union Commission, Ed*.

Alexander, A.S., 2002. *Chapter 3: Data, information and meaning*. Available at: https://repository.up.ac.za/dspace/bitstream/handle/2263/27367/03chapter3.pdf. (Accessed 17 April 2018).

Beaver, D. D., 2004. Does collaborative research have greater epistemic authority? *Scientometrics*, *60*(3), pp. 399-408.

Bellinger, G., Castro, D and Mills, A., 2004. *Data, information, knowledge, and wisdom*. Available at: http://www.academia.edu/download/35500195/bellinger_on_ackoff_data_info_know_wisdom.pdf. (Accessed 17 April 2018).

Chatti, M. A., Jarke, M. and Frosch-Wilke, D., 2007. The future of e-learning: a shift to knowledge networking and social software. *International journal of knowledge and learning*, *3*(4-5), pp. 404-420.

Cummings, J. N. and Kiesler, S., 2005. Collaborative research across disciplinary and organizational boundaries. *Social studies of science*, *35*(5), pp.703-722.

Datta, A., 2018. *Strengthening research systems: concepts, actions and actors*. Available at: https://assets.publishing.service.gov.uk/media/5bb22520ed915d25b3049d31/429-430_Research_systems_-_concepts_actions_and_actors.pdf. (Accessed 07 January 2020).

Davenport, S., Davies, J. and Grimes, C., 1998. Collaborative research programmes: building trust from difference. *Technovation*, *19* (1), pp. 31-40.

Davenport, T. H. and Prusak, L., 1998. *Working knowledge: How organizations manage what they know*. Boston: Harvard Business Press.

Di Giorgio, S., 2017. *Open Data, Open Science, Open Access*. Available online at: http://training.parthenos-project.eu/wp-content/uploads/2017/07/Open-Data-Open-Science-Open-Access-Transcription-ENGLISH.pdf (Accessed 11 June 2019).

Economic and Social Research Council (ESRC), 2020. *Tips for doing knowledge exchange*. Available at: https://esrc.ukri.org/research/impact-toolkit/tips-for-doing-knowledge-exchange/ (Accessed 08 January 2020).

Fazey, I., Fazey, J.A. and Fazey, D.M.A., 2005. Learning more effectively from experience. *Ecology and Society10 (2) [online]* Available at: http://www.ecologyandsociety.org/vol10/iss2/art4/ (Accessed 30 December 2019).

Global System for Sustainable Development (GSSD), (n.d.). *Knowledge meta-networking for decision and strategy*. Available at: https://gssd.mit.edu/knowledge-system (Accessed 14 April 2020).

Hessels, L. K., 2013. Coordination in the science system: theoretical framework and a case study of an intermediary organization. *Minerva*, *51*(3), pp. 317-339.

Hustad, E., 2004. Knowledge networking in global organizations: the transfer of knowledge. In: *Proceedings of the 2004 SIGMIS conference on Computer personnel research: Careers, culture, and ethics in a networked environment* (pp. 55-64). New York City: ACM.

Iizuka, M., Mawoko, P. and Gault, F., 2015. Innovation for development in Southern & Eastern Africa: challenges for promoting ST&I Policy. *UNU-MERIT Policy Brief*, *1,* pp.1-8.

Introna, L.D., 1992. *Towards a theory of management information*. Unpublished DCom-Thesis, Department of Informatics, University of Pretoria, Pretoria.

Jean-Louis, D. and Lomas, J., 2003. Convergent evolution: the academic and policy roots of collaborative research. *Journal of health services research & policy*, *8*, S1.

Jessup, R. L., Osborne, R. H., Buchbinder, R. and Beauchamp, A., 2018. Using co-design to develop interventions to address health literacy needs in a hospitalised population. *BMC health services research*, *18*(1), p. 989.

Lessing, A. and De Witt, M., 2007. The value of continuous professional development: teachers' perceptions. *South African Journal of Education*, *27*(1), pp. 53-67.

Liew, A., 2007. Understanding data, information, knowledge and their inter-relationships. *Journal of Knowledge Management Practice*, *8*(2), pp. 1-16.

London School of Economics and Political Science, 2020. Introduction to knowledge exchange and public engagement. Available at: https://info.lse.ac.uk/staff/services/knowledge-exchange-and-impact/kei-guide/introduction-to-kei. (Accessed 08 January 2020).

Marcelle, G., Daniels, C. and Whisgary, D., 2014. A strategy for leading science, technology and innovation in Africa. *HSRC Review*, *13*(1), pp. 25-26.

Markman, G. D., Siegel, D. S. and Wright, M., 2008. Research and technology commercialization. *Journal of Management Studies*, *45*(8), pp. 1401-1423.

Marshall, G., Punys, V. and Sykes, A., 2008. The continuous professional development (CPD) requirements of radiographers in Europe: an initial survey. *Radiography, 14*(4), pp. 332-342.

Martin, K., Stevens, A. and Arbour, S., 2017. The process of developing a co-design and co-delivery initiative for mental health programming. *Journal of Psychosocial Rehabilitation and Mental Health*, *4*(2), pp. 247-251.

McGann, J. G., 2020. 2019 Global Go To Think Tank Index Report (2020). *TTCSP Global Go To Think Tank Index Reports*. *17*. Available online at: https://repository.upenn.edu/cgi/viewcontent.cgi?article=1018&context=think_tanks (Accessed 8 April, 2020).

Mentzas, G., Apostolou, D., Young, R. and Abecker, A., 2001. Knowledge networking: a holistic solution for leveraging corporate knowledge. *Journal of Knowledge Management*, *5*(1), pp. 94-107.

National Academy of Sciences, 1994. *The knowledge exchange process: from research into practice*. Available at: https://www.ncbi.nlm.nih.gov/books/NBK236316/ (Accessed: 08 January 2020).

Nonaka, I., Toyama, R. and Nagata, A., 2000. A firm as a knowledge-creating entity: a new perspective on the theory of the firm. *Industrial and Corporate Change*, *9* (1), pp.1-20.

Opfer, V. D. and Pedder, D., 2010. Benefits, status and effectiveness of continuous professional development for teachers in England. *The Curriculum Journal*, *21*(4), pp. 413-431.

Oyelaran-Oyeyinka, B., Ozor, N., Vallejo, B. and Abejirin, B., 2018. *Towards effective public-private partnerships in research and innovation: a perspective for African science granting councils*.

Parinov, S. and Neylon, C., 2011. Science as a social system and virtual research environment. *Journal of Artificial Societies and Social Simulation*, *14*(4), p. 10.

Plum, O. and Hassink, R., 2011. Comparing knowledge networking in different knowledge bases in Germany. *Papers in Regional Science*, *90*(2), pp. 355-371.

Rasmussen, E., 2008. Government instruments to support the commercialization of university research: Lessons from Canada. *Technovation*, *28*(8), pp. 506-517.

Ryan, J., 2003. Continuous professional development along the continuum of lifelong learning. *Nurse Education Today*, *23*(7), pp. 498-508.

Seufert, A., Von Krogh, G. and Back, A., 2004. Towards knowledge networking. In: *Business Engineering—Die ersten 15 Jahre*. Springer, Berlin, Heidelberg. pp. 289-308.

Sharp, P., 2007. MaKE first steps–how a definition of knowledge can help your organisation. *The Electronic Journal of Knowledge Management*, *5*(4), pp. 487-496.

Skyrme, D., 2007. *Knowledge networking: creating the collaborative enterprise*. Routledge.

Sprunger, J. G., 2017. The benefits of engaging in collaborative research relationships. *APS Observer*, *30*(10).

Svendsen, A. and Laberge, M., 2006. Beyond consultation: a co-creative approach to stakeholder engagement. Available at: http://www.sfu.ca/sustainabledevelopment/cli/beyondconsultation.pdf (Accessed 10 January 2020).

Thierauf, R. J. (1999). *Knowledge management systems for business*. Westport, Connecticut, USA: Greenwood Publishing Group.

United Nations International Children's Emergency Fund (UNICEF) (2015). 'What is knowledge exchange?' Available at: https://www.unicef.org/knowledge-exchange/ (Accessed: 08 January 2020).

United Nations International Children's Emergency Fund (UNICEF) (2015) 'Learning and knowledge exchange' New York: UNICEF. Available at: https://www.unicef.org/knowledge-exchange/ (Accessed: 26 December 2019).

Vargas, J. and Venezia, A. (2015). Co-Design, Co-Delivery, and Co-Validation: Creating High School and College Partnerships to Increase Postsecondary Success. *Jobs for the Future*.

Vicente-Saez, R. and Martinez-Fuentes, C. (2018). Open Science now: A systematic literature review for an integrated definition, Journal of Business Research, Volume 88; Pages 428-436, ISSN 0148-2963, https://doi.org/10.1016/j.jbusres.2017.12.043.

Vetro, A., Canova, L., Torchiano, M., Minotas, C. O., Iemma, R. and Morando, F. (2016). Open data quality measurement framework: Definition and application to Open Government Data. Government Information Quarterly, 33(2), 325–337. doi:10.1016/j.giq.2016.02.001; http://www.soros.org/openaccess.

Ward, M., De Brún, A., Beirne, D., Conway, C., Cunningham, U., English, A., ... and McDonnell, S. (2018). Using co-design to develop a collective leadership intervention for healthcare teams to improve safety culture. *International Journal of Environmental Research and Public Health*, *15*(6), p1182.

Wasserman, S. I., Kimball, H. R. and Duffy, F. D. (2000). Recertification in internal medicine: A program of continuous professional development. *Annals of Internal Medicine*, *133*(3), p202-208.

World Bank (2017). The art of knowledge exchange'. Available at: https://www.thegef.org/sites/default/files/publications/GEF_WB_AoKE_English.pdf. (Accessed: 08 January 2020).

Wray, K. B. (2002). The epistemic significance of collaborative research. *Philosophy of Science*, *69*(1), p150-168.