Demystifying Science: Insights on the challenges of science communication in Ghana

by

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Abstract

Innovative solutions from science and technology have profoundly improved people's quality of life, health, and economic advancement worldwide. Moreover, as Carl Sagan (1990) rightly said, we live in a society "exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology." Science and communication reveal and connect the world to the unknown. Without building a bridge between these two fields, our world will be rife with misconceptions and false information about science-related solutions. Science communication provides an excellent avenue for embracing innovations; however, despite the current growth in scientific knowledge tailored toward solving problems in developing countries, public engagement with scientific studies is minimal. This thesis explored the perceived challenges of communicating science in Ghana using in-depth interviews and discourse analysis as a theoretical framework. The findings of the study suggest that the perceived challenges of communicating science in Ghana are related to (a) science communication as an economic luxury (b) culture, beliefs, and taboos as a filter for science communication, and (c) science communication as an enabler of systematic bias. Responding to RQ2, participants' discourse was positioned around one dominant moment of science communication as a collaborative effort.

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Dedication

This thesis is dedicated to the people who have supported me throughout my academic journey. For Barbs, Ballad and Mag, thanks for being my backbone.

Chapter 1 - Introduction

Demystifying Science: Insights on the Challenges of Science Communication in Ghana

Innovative solutions from science and technology have profoundly improved people's quality of life, health, and economic advancement worldwide. And as Carl Sagan (1990) rightly said, we live in a society "exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology." Science and communication reveal and connect the world to the unknown. Without building a bridge between these two fields, our world will be rife with misconceptions and false information about science-related solutions. The knowledge produced by science plays a significant role in countries' health, and socio-economic growth.

In 2019, the outbreak of the COVID-19 pandemic clasped its tentacles around the world, taking lives and leaving several people in despair. As we currently live in an information age, this led to another pandemic described by the World Health Organization (2021) as an "infodemic." The infodemic left the world vulnerable to the influx of toxic disinformation. The overflow of such information has been actively promoted by members of the public and individuals with a large following that the public look up to or is regarded as reliable. For instance, political elites have actively promoted fake cures for the virus, such as President Trump and Brazilian President Jair Bolsonaro, who claimed hydroxychloroquine was a treatment against the virus (Stargardter & Paraguassu, 2020; The Guardian, 2020).

On the other hand, academic elites also served as active modes of transmission of false cures. For instance, in Ghana, West Africa, Prof. Andrew Seth Ayettey, a retired professor from the University of Ghana Medical School, recommended Hydrogen Peroxide (H202) as a cure for COVID-19 (Ayettey, 2021). Current studies do not provide sufficient evidence of these two supposed cures for COVID-19 (Kampf et al., 2020; WHO, 2021). The two unproven cures have

dire consequences for the world's health. For instance, in February 202, Ghana's Food and Drugs Authority issued a press release on the shortage of Hydrogen Peroxide and evidence of sub-standard versions in Ghana despite issuing a previous statement indicating that there is no evidence of its efficacy as a cure for COVID-19 (Affre; 2021; CitiNews, 2021).

Without a confirmed treatment that eradicates the virus, van der Linden et al. (2020) point out that managing the pandemic and infodemic requires leveraging insights from the social and behavioral sciences to intervene and contain the spread of misinformation about COVID-19. Several scholars have risen to the challenge by engaging in science communication scholarship with a particular interest in managing fake news (van der Linden et al., 2020), rapid and effective science communication (Kearns & Kearns, 2020), understanding of science during a pandemic (Abdool Karim, 2022), trust in scientific expertise (van Dijck & Alinejad; 2020) and the impact of COVID-19 communication on mental health (Pimenta et al., 2020). Science communication, therefore, provides a conducive environment for the public to embrace the future and scientific innovations by breaking down scientific information on issues such as climate change. Hence the public can make informed decisions as the mistrust and misunderstanding of scientists, and their research is lessened through their engagement with science (Brownell et al., 2013). In the same vein, the complex nature of scientific methods and the constant introduction of innovations tailored to developed countries can also make communicating science to the public in developing nations complicated. Approximately 5–10% of all global health research funding is directed to research on health problems that affect 90% of the world's population. Only a small proportion of this funding goes to researchers in developing countries (Harris, 2004). This disparity is known as the 10/90 gap, a term coined by the Global Forum for Health Research in 1990. According to a report by the Global Forum for Health Research, 'strengthening research capacity in developing countries is one of the most effective and sustainable ways of advancing health

and development in these countries' (Global Forum for Health Research, 1999, p. 126 as cited in Harris, 2004, p.7). Thus, communicating science needs to reflect its environment's social and cultural context as well as the local needs of developing countries.

Relevance of the Study

Scholarship in science communication is a fusion of works from diverse fields. The academic community has extensively explored this interdisciplinary field, its definition (Gascoigne et al., 2020), the appropriate skills (Burns et al., 2003), the challenges and gaps, and possible ways of effectively engaging the public (Bricker, 2013). According to Guenther and Joubert (2017), from a historical perspective, scholarly activity within the field has "traditionally been dominated by male authors from English-speaking countries in the West" (p.1). However, other studies (Gascoigne et al., 2010; Guenther & Joubert, 2017) extrapolate heightened interest in recent years with increased publications and cross-institutional and cross-country collaboration. Despite the increasing global interest, science communication research in this field is shaped by the authors' priorities and needs; thus, research outputs reflect regional differences (Guenther & Joubert, 2017). In 2017, Guenther & Joubert analyzed the three most prominent journals within the science communication field —Science Communication: Linking Theory and Practice, Public Understanding of Science, and the Journal of Science Communication from 1979 to 2016. Out of 1803 papers published during this period, 20 articles were from Africa, representing 1.1%, with the majority based in North America and Europe. These findings arguably underscore the need for more research contributions from developing countries to provide a different perspective to the field. Guenther & Joubert cite some plausible causes for the low representation of science communication research output from the southern hemisphere. The authors point out that historically, science was suppressed in countries like South Africa and Brazil by their colonial masters. They also highlight barriers such as funding, lack of incentives, censoring of

politically sensitive findings, and perceived clashes between modern scientific knowledge and indigenous knowledge (Guenther & Joubert, 2017). Other findings by Trench and Bucchi (2015) echo similar sentiments, surmising that while science communication research from Europe is professionally autonomous and somewhat independent of government, developing countries tend to be influenced by "policy agendas through funding mechanism or direct provision of organizational resources" (Trench and Bucchi, 2015, p9). Guenther & Joubert (2017) also argue that calls for special issues by journals are commendable; however, collaborative research would be a more effective way of stimulating diversity in research authorship. Their findings also assert that early inequities remain prevalent, but current trends are beginning to correct some of these imbalances in research output.

Narratives on science communication in Africa have shifted with scholars focusing on its origins in Ghana (Tagoe & Tagoe, 2020), the advantages of science communication in the broader African context (Gascoigne et al., (2020), and how African researchers practice science communication (Ndlovu et al., 2016). The works of authors such as Tagoe and Tagoe (2020) (the origin of science communication in Ghana), Gascoigne and colleagues (2020) (a global perspective to science communication that highlights efforts in Africa), and Ndlovu et al. (2016) (science communication views and practices of African researchers) are some examples of how the narrative is shifting to encapsulate different perspectives and knowledge. However, Guenther and Joubert (2017) conclude that despite the increase in scholarship, "developing countries are underrepresented," with Africa representing only 1.1% of the total research output from 1979 to 2016.

Existing studies on recommendations for practicing science communication are generally dominated by western research providing western solutions that do not necessarily address the problems in developing countries in West Africa (see Bauer et al., 2007; Bricker, 2013;

Holliman, 2005; Mercer-Mapstone & Kuchel, 2015; Salmon & Roop, 2019; Wang et al., 2018). Other research studies focus on science communication from a global perspective (Gascoigne et al., 2020), while others conceptualize science communication in response to social changes brought about by digital media (Fähnrich,2021). Bricker's (2013) case study of "Climategate" paints a picture of how European political affiliations influence news commentators and conservative pundits present science-related data for public consumption and the irreparable ripple effects of taking information out of context. Bauer et al. (2007) also review crucial issues relating to the public's understanding of science (PUS) in the last quarter of a century, tracing the public's perception of science, its communication, and its influence by governments, businesses, and scientific institutions. The authors assert that science communication and the public's understanding of science is a burgeoning field of research, but their focus is on the European perspective (UK, Ireland, France, Germany, Portugal, and Denmark).

Another study worthy to note is Kahan (2010). Kahan talks about how people make polarized decisions on science-related issues based on a position that reinforces their connection to others with whom they share significant commitments. He states this is especially true when the public harden their resistance and increase their willingness to support alternative arguments, no matter how lacking in evidence. This reaction is often reinforced when a message is put across by public communicators unmistakably associated with cultural outlooks or styles — the more so if such advocates indulge in partisan rhetoric, ridiculing opponents as devoid of reason. Kahan also touches on some strategies that could help fix communication failure backed by the best available science. However, there are varying needs for and responses to scientific information dissemination that universal solutions cannot address in local West African contexts. Gascoigne et al. (2020), one of the few sources that provide a global perspective on science communication that highlights efforts in Africa, argue that access to scientific knowledge, its

production, benefits, opportunities, and communication is uneven across the world. Therefore, this piece is partly a response to Putnam's (2000) call for communication scholars to address complex and diverse social problems that call for our expertise "by engaging in alternative modes of discourse—ones that center on multiple and shifting voices and oppositional discourse" to develop complementary ways of understanding (Putnam, 2000, p. 38).

This thesis also responds to two of the five priority themes of science communication research proposed by Trench and Bucchi (2015) as areas that deserve attention in the next generation of research. Trench and Bucchi identified priority themes (a) Increasing fragmentation of actors, publics, and media (b) New mediations (c) Collapsing communication contexts (d) Science in society and science in culture, and (e) Global trends and challenges, as pertinent to the evolution of science communication research. Of interest to this thesis is (d) and (e) because they encourage scholars to consider science communication research as a dissection of "how society talks about science," which hints at a closer look at the cultural contexts within which science is communicated. They also suggest the probing of global trends and challenges of communicating science because the "public communication of science has become a global enterprise with common denominators as well as distinctive regional characterizations" (Trench & Bucchi, 2015, pp. 6-7). By doing so, our field can explore several opportunities to analyze science communication patterns from different cultural, policy, and sociopolitical landscapes.

By centering on the lived experiences of science communicators in Ghana, this study endeavored to unearth the sense-making of science communication and its challenges by paying attention to "the person-in-situation" (Dervin, 1998). Thus, in this thesis, I applied in-depth interviews as a methodological strategy to identify the challenges of science communicators in Ghana, a country in West Africa. This thesis examines science communicators' perceptions of

the cause of the situation by illuminating their voices and experiences. Finally, I explore possible interventions to sustain science communication practice in Ghana.

By capturing local voices, this study probes the connection between the social reality and culture of Ghanaians influencing the discourse and sense-making of science. People's collective perceptions or attitudes often "exist only in so far as their members create them through discourse" (Grant et al., 2004). This thesis, therefore, draws from Gee's (1989) Discourse theory which describes Discourse as an identity kit with the appropriate costume and instructions on how to act, talk, and often write to take on a particular role that others will recognize. Gee also clarifies that Discourse encompasses five factors: saying, doing, being, valuing, and believing. Thus, this thesis explores how the Ghanaian ways of behaving, believing, interacting, thinking, interpreting, writing, and reading influence how science is communicated and its possible connection to the challenges experienced by science communicators in the country.

Science Communication's role in Society

In 2010, Trench and Bucchi described science communication as an emerging discipline with an uncertain status. However, science communication has grown exponentially over the years as an interdisciplinary field gaining worldwide attention (Guenther & Joubert, 2017). The objective of a science communication endeavor can range from simply sharing "the findings and excitement of science" to increasing knowledge and "appreciation for science as a useful way of understanding and navigating the modern world" or influencing decision-making, people's opinions, behaviors, and policy preferences (National Academy of Sciences, 2017, p.83). The knowledge produced through scientific research on timely issues such as COVID-19 and climate change prioritizes evidence-based expertise for individual, organizational, and societal decisions. Thus, science communication provides a channel for dialogue between the scientific community and the public and the application of knowledge in real-life situations.

Prior research also substantiates the belief that science communication has direct and indirect benefits to society's growth, and scholars such as Davies (2021) suggest that "an integral part of becoming adept in science communication is the ability to reflect on its role in society" (Davies, 2021, p.118). Burns et al. (2003) clarify that science communication is not solely for the benefit of the lay public as the field provides a deeper understanding and different perspectives of relevant social issues for decision-makers, governments, scientific businesses, and the media in making informed decisions. This claim is further solidified by Bubela et al. (2009), who point out that engagement and awareness of science are fundamentally important for a public that bears the risks and benefits of scientific and technological development. Durant et al. (1989) also answer a salient question that plays a vital role in grasping the societal value of science communication. According to Durant and his colleagues (Durant et al., 1989, as cited in Davies, 2021), "science is arguably the greatest achievement of our culture, and people deserve to know about it; second, science affects everyone's lives, and people need to know about it." Hence, an informed public can engage in an inclusive public debate for many public policy decisions, further enhancing democratic discourse and increasing public support and trust in science. Durant et al. (1989)'s response surmises the influence of science communication on culture, democracy, and public policymaking.

Science communication ensures accountability and promotion of publicly funded research. Studies by Davies (2021) and Bubela et al. (2009) contend that science communication's role is often affiliated with accounting for research funded by the public purse and maintaining public trust. It also plays a pragmatic or instrumental role in propagating relevant information for individuals to navigate a technologically saturated society and for politicians to make wise political decisions (Davies, 2021). Science communication provides a medium for making sense of the world, wielding both educative and entertainment potential.

Finally, it also serves as a means of promoting the scientific prowess of individuals, institutions, and nations to bridge the gap between the scientific community and the public. As Davies rightly summarizes, the value of science communication "goes beyond the instrumental or normative (or even moral, as in arguments about accountability) to include the aesthetic and pleasurable" (Davies, 2021, p.125). Consequently, the value of scientific communication pervades different aspects of society, its progress, and the decision-making process.

Why focus on Ghana?

This research appealed to me mainly due to my personal experience and challenges as an undergraduate student new to science communication. During my first year in undergraduate school, I began volunteering for a non-profit. That was when I realized there was no laid down procedure for practicing science communication or role models within the country that one could glean knowledge from their experiences. Even though I was working towards a communication studies degree from Ghana's premier communication school, science communication was an area of study that was barely mentioned. My first-time experience in this field was more of a trial-and-error period. By shedding light on the challenges of science communication based on the lived realities of those on the ground, I hope that it opens discussions for Ghanaian scholars within the communication and scientific field on the practical means or ways of making it a more attractive and lucrative field of study or practice for the younger generation, as it is often not regarded in high esteem or at the same level as other areas of journalism in Ghana.

Science communication is recently gaining more attention in Ghana and other parts of sub-Sahara Africa, especially after the global COVID-19 pandemic. Many African countries look up to Ghana due to its significant geo-political and historical position, mainly because it is the first country in Africa to break away from colonial rule and gain independence. Ghana's president, H.E. Nana Akufo-Addo, is currently the head of the Economic Community of West

African States (ECOWAS), a regional political and economic union of fifteen countries located in West Africa. Ghana is also highly respected as a founding member of the African Union (AU) and often adhered to, especially during civil unrest in other African countries. Ghana often leads the charge for peacekeeping and democratic governance in Africa. Thus, championing science communication in Ghana is indirectly linked to advocating science communication in West Africa. A gateway to laying the foundation for a future built on technology and innovation with people well-versed in the benefits of scientific advancement.

Ghana is also known for its rich cultural diversity, home to over 90 ethnic groups, each with its unique language, cultural traditions, beliefs, customs, and practices, which adds to the richness and diversity of Ghanaian culture. In addition to these ethnic groups, other smaller groups or subethnic groups contribute to Ghana's cultural diversity (Minority Rights Group International, 2015). Ghana's culture is dynamic and constantly evolving; thus, it provides a unique opportunity to contribute to existing studies on science communication from the context of developing countries with multifaced cultural underpinnings.

Science Communication in Ghana is crucial not just for the country itself but for West African countries. Ghana has been the focal point for several scholars who have contributed to understanding how people in developing countries use technology (Zachary, 2004), conflict resolution (Yakohene & Appiah, 2022), intellectual activism, the development of black studies and political education (Gyamfi, 2021). The first president of Ghana, Dr. Kwame Nkrumah, was a visionary who valued the application of science and technology, establishing one of the first universities in Africa to focus on science, the University of Science and Technology, in 1952, now the Kwame Nkrumah University of Science and Technology. The future of technological advancement in Ghana is promising, but as Tagoe and Tagoe (2020) posit, "this is meaningless if it is never communicated to the masses." (Tagoe & Tagoe, 2020, p.367). Without effective

communication of scientific knowledge, how can the public make the right decisions that could potentially benefit or harm them? Paying more attention to science communication could help resolve myths about scientific solutions (e.g., COVID-19 vaccinations), traditional beliefs, practices, and other relevant issues that adversely affect the public's health, livelihood, and future.

Over the years, there have been efforts by journalists and organizations in Ghana to establish an organized group of people whose primary focus is communicating science to the public. According to Tagoe & Tagoe (2020), "the current state of science communication in Ghana can be traced back to institutional interventions initiated by Nkrumah as the country's first president. From universities to associations and training institutes for journalism, his contributions cannot be ignored" (p.365). Despite its rich history entangled with the first president's "unwavering belief that science and technology held the key to rapid national development to raise the quality of life for all citizens," science communication has long been overshadowed by other fractions of journalism (Tagoe & Tagoe, 2020). The fractions focusing on other areas such as business, politics, foreign affairs, and entertainment tend to hold more relevance and airtime on Ghanaian media and thus dominate public conversations.

Before COVID-19, significant efforts to communicate science were often spearheaded by independent efforts of non-profits, the West African Center for Cell Biology of Infectious Pathogens (WACCBIP), and the Ghana Science Association (GSA). There have been visible efforts to advance science communication including Ghana Science Association's The Horizon, "an hour-long segment on morning radio where professionals and enthusiasts discuss their areas of expertise within STEM" (Tagoe & Tagoe, 2020, p.355). The other is STEM web (pseudonym), a science communication nonprofit that organizes outreach programs, including an art exhibition that portrays the Evolution of Science through art at Ghana's Museum of Science

and Technology. Outside the confines of these organizations, science communication by the Ghanaian media is crammed with carbon copies or synthesized versions from foreign news websites with limited original or local content on science.

2022 was a significant year for science communication in Ghana because STEM web took strategic steps towards increasing science communication through a fellowship program for journalists in Ghana. However, how can such efforts be sustainable without a critical look at the challenges faced by those who have plied this route over the years without establishing a formidable, organized group of science communicators? Even if there is no absolute answer to this question, understanding the current landscape could be a reference point to improve, reform, and evaluate current endeavors toward science communication in Ghana. Tagoe & Tagoe's (2020) reflections vividly depict individual efforts toward bridging the gap between science and the public. It touches on the history of science communication in Ghana and how its resilient science communication practice manifests in several folds through individuals, the media, and institutions or organizations. However, research needs to capture the challenges in communicating science in Ghana and further probe into the need for resilience or how science communicators can sustain the practice. This study, therefore, seeks to understand this phenomenon by asking:

RQ1: What are science communicators' perceptions regarding the underlining challenges of science communication in Ghana?

RQ2: How do science communicators perceive local science communication interventions in Ghana?

In what follows, after recalling other scholars' definitions of what science communication could be/do, I reflect on the models of science communication and the type of model practiced in Ghana. I also reflect on the existing literature that shows how current scholars focus on the

application of science communication in making an impact and changing perceptions before plying the road less traveled by most scholars, which is to highlight the challenges of science communicators in Sub Sahara Africa from the local context. I then conclude with an assessment of the interviews and a reflection on the research participants' responses, pondering how they fit or fill the gaps in existing scholarship on the subject under study.

Chapter 2 - Literature Review

Bryant (2003) describes science communication as "the processes by which the culture and knowledge of science are absorbed into the culture of the wider community" (Bryant, 2003, p. 357). He explains that science communication is not homogeneous; different communities bring different intellectual baggage to their understanding of science. Thus, this definition is appropriate for this discussion. Bryant's statement highlights the multifaceted impact and challenges of communicating science in different geographical areas. In this chapter, I discuss the definition and scope of science communication, the different approaches to communicating science, and finally, the theoretical framework for this thesis.

Definition and scope of science communication

In recent years, more so since the global COVID-19 pandemic, scholars have been paying particular attention to science communication and strategies to improve public engagement with science-related information. Gascoigne et al. define science communication as the 'use of the impact of the media and other channels of communication to disseminate scientific findings with a focus concentrated on a communication process that is reliant on multimedia through journalistic reporting on mainstream and social media, and exhibition of science in museums." (Gascoigne et. al, 2020, p.51). Burns et al. posit that science communication is the use of appropriate skills, media, activities, and dialogue to produce awareness, appreciation, interest, or understanding of scientific content or processes (Burns et al., 2003). Science communication applies tools and techniques from social and behavioral sciences, as well as from humanities. At the same time, scholars in the field are typically trained in social science disciplines such as sociology, communication studies, and media studies or in related fields of humanities such as philosophy or rhetoric (Hornig Priest, 2007; Hornig Priest, 2010 as cited in Guenther & Joubert, 2017). Science communication requires engaging in

translating complex science into language and concepts that are engaging and understandable (Mercer-Mapstone & Kuchel, 2015). According to Petronio (1999), "translating scholarship is based on the fundamental approaches to solving practical concerns by using the science of interpretation to translate theoretical orientations and research findings into useable information in the everyday world" (p. 87). Our field, therefore, finds itself in an enviable position capable of demystifying science by bridging the gap between the public and science. Several intellectuals have set a precedent, laying the groundwork for communicating with the public about science. For instance, Salmon and Roop (2019) thoroughly examined how to bridge the gap between science and the public. They provide insight into the need for training, resources, and structures for strategic engagement in science communication. However, science communication needs to adopt more creative methods of engaging the public as the world is now tilted towards more interactive mediums such as social media. Salmon and Roop's (2019) recommendations align in the opposite direction of the dominant approach to communicating science issues, the deficit model of science communication, where the media and education programs provide the public with more facts to increase general knowledge about scientific information.

Science communicators focus on a variety of areas, such as climate change (Anaafo, 2017), health (Thompson et al., 2021), and the natural sciences (Guenther & Guenther, 2017). Prior research also shows that a variety of mediums are used in communicating science like social media, tv, print (van Dijck & Alinejad, 2020), local radio (Anaafo, 2017), and public engagement (Ndlovu et al., 2016). Aside from these mediums, a study by Thompson et al. (2021) extrapolated that music was a common medium for creating awareness about COVID-19. Half of their sample size used multiple languages to provide health guidelines, dispel misinformation about the virus, and inspire hope and a call to action (Thompson et al., 2021). In 2017, an empirical study conducted by Anaafo shows that local radio, tv, and some government

departments are the primary sources of information dissemination on climate change in rural areas in Ghana (Anaafo, 2017).

The models of science communication

Science communicators often communicate to the public using the deficit, contextual, or participation model of science communication. The deficit model of science communication attributes public skepticism or hostility to science and technology to a lack of understanding resulting from a lack of information; hence the model emphasizes the repetition of information to increase public awareness. On the other hand, scientists in the contextual model craft their delivery of scientific information by considering the audience's "needs, attitudes, and existing knowledge of their different audiences and adjust their content and communication approach accordingly" (Carl Zimmer, 2014, p.15). The participant model requires equal participation of scientists, the public, and policymakers in discussions relating to science. This approach allows dialogue leading to maximum impact and social change through science. For decades, the deficit model has remained the most prominent view of communicating science, presenting a public deficiency in knowledge, attitude, and trust (Bauer, Allum, & Miller, 2007). This approach relays information that remains true to science's tenets, yet it often comes off as emotionless. Nonetheless, science communicators can relay information more compellingly by moving away from viewing the audience as passive in a one-way communication process and still staying true to their scientific principles. Science communicators must consider other communication modules that view dialogue and deliberation between the public, experts, and decision-makers who actively process information before deciding (Kappel & Holmen, 2019).

Even though the deficit model remains the dominant approach to communicating science, Bauer, Allum, & Miller's (2007) critique of the model calls to attention the need to realize that the deficit is not with the public but with the scientific institutions and expert actors who harbor

prejudices about an ignorant public. Bauer et al. (2007) assert that a better understanding of the public's understanding of science would require a diagnosis of institutional neurosis. Expert actors (scientists, researchers, science communicators, and institutions) must consider the relevance of the information shared and the ability and motivation of the public to process the information to influence, persuade or change their attitudes.

Today, with communication scholars veering toward a more participatory or dialogue approach to communicating science, communication experts now consider the deficit obsolete (Reincke et al., 2020). In Ghana, science communication follows both the deficit and dialogue models. News stories on most Ghanaian websites adhere to the deficit model of science communication (Karikari et al., 2016), while outreach programs by organizations such as STEM web and Ghana Science Association follow the dialogue model, which allows public engagement with scientific knowledge. According to Reincke et al., "the dialogue model foregrounds a two-way flow of information from expert to layperson and vice versa." (Reincke et al., 2020, p.1). Hence this encourages discourse between the audience and science communicators, exposing diverse "views, values, experiences, and concerns from the audience with the intention to learn with and from each other." (Reincke et al., 2020, p.2). This model also allows science communicators to build relationships with the public, providing a means through which scientific researchers can leave the ivory tower of knowledge production and convey the results of their expertise to those likely to be affected by the implications of those results (Bricker, 2013).

In Ghana, science communication through dialogue can be geared towards developing a targeted behavioral change towards misconceptions relating to science and technology. As of 2021, Ghana's literacy rate is 69.8% (Gyesi, 2022). Even though this is significant, those outside this percentage, especially within rural areas, have some entrenched beliefs and practices that view science with skepticism. This reflects similar situations in other rural parts of West Africa

where science communication could significantly impact health and the overall way of life through public engagements and outreach programs. Studies by Weingart et al. (2019), Joubert & Mkansi (2020), and Joubert (2020) are the few that closely reflect the challenges of communicating science in West Africa yet are centered on the southern part of the continent. The authors emphasize the application of public engagement and the relevance of politics, culture, and socioeconomic realities in sculpting how science is communicated to the public. Their recommendation highlights the relevance of local voices and their lived realities in shaping how communication about science is enacted through dialogue to make an impact.

Vu and his colleagues, in a 2021 study, analyzed the framing of climate change messages by 289 global climate nonprofits from 18 countries. Vu et al. (2021) argue that nonprofits in developing countries have tailored climate change messaging to reflect the realities of increased agricultural hardships and social vulnerabilities stemming from a warming planet, working to educate its populace on strategies for adaptation to climate change effects (Ford et al., 2015 as cited in Vu et al., 2021). The findings prove that in Africa, science communication by NGOs is tailored toward deficit discourse, while developed countries situate their messages within a larger national discourse. Deficit discourse refers to "disempowering patterns of thought, language and practice that represent people in terms of deficiencies and failures. It particularly refers to discourse that places responsibility for problems with the affected individuals or communities, overlooking the larger socio-economic structures in which they are embedded" (Fogarty et al., 2018). Their results are vital in understanding the scope of science communication in developing countries as NGOs act "as mediators between scientific expertise and the public" (Ladle et al., 2005 as cited in Vu et al., 2021, p.92). The authors point out that some of their messages are from developed countries influenced by competition among industries, scientists, NGOs, and policymakers, with each aiming "to frame the issue according to their particular agenda" (Vu et

al., 2021, p.94). The authors contend that these NGOs preferred discussing the impacts of climate change, which indicates a disconnect between strategic framing research on climate change and professional practices of climate change communicators who would consider proximity when framing messages to trigger response or action.

Gee's theory of Discourse and its implications on Science Communication

The way people communicate, act, value, think, and believe is often dependent on the context that they are in. People act as individuals and members of various sociocultural groups associated with different identities. Gee's theory of Discourse is grounded in social and cultural views of literacy, which suggests that context, history, culture, discourse, power, and beliefs influence interactions. For instance, one can be a science communicator in Europe, America, Asia, or Africa. Still, the value, perception, interactions, or Discourse about science may be different based on which part of the world they find themselves in. Gee describes Discourse as a "sort of identity kit which comes complete with the appropriate customs and instructions on how to act, talk and often write, so as to take on a particular role that others will recognize" (Gee, 1989, p.526). He further expands this in subsequent writings as "the ways in which such socially based group conventions allow people to enact specific identities and activities. (Gee, 2012, p.1). Gee also posits that a person's primary Discourse (discourse that provides us with our initial sense of self) can experience conflict with the secondary Discourse which is acquired through socialization within the public sphere (Gee, 2012). Science communicators may therefore speak, act, think, and write like science communicators; however, the enactment of these specific identities or activities may cause tensions or conflict with the Discourse of their target audience.

These conflicts or tensions can be a source of resistance when science-related information is introduced into the public's discourse. Thus, science communicators from different social and cultural contexts need to examine their discourses to better understand who they are as science

communicators and how their Discourses (ways of speaking, listening, reading, and/or writing integrated with ways of acting, interacting, valuing, feeling, dressing, thinking, and believing), might clash with deep-rooted beliefs, perceptions, or values of the public (Stevens, 2016). Thus, applying in-depth interviews as a methodological strategy for this study is also helpful in identifying the underlying challenges of indigenous science communicators instead of blindly using universal solutions to local challenges under unique circumstances.

In this chapter, I elaborated on the definitions and scope of science communication and the models of science communication. I also discussed how Gee's Discourse theory provides a different lens for analyzing the challenges of science communicators based on their lived experiences, beliefs, values, and perceptions, which often have deep roots within cultural doctrines. The purpose of looking at the challenges of science communicators from this theoretical perspective is to answer the following research questions:

RQ1: What are science communicators' perceptions regarding the underlining challenges of science communication in Ghana?

RQ2: How do science communicators perceive local science communication interventions in Ghana?

Chapter 3 - Methodology

This chapter introduces the research methodology for this qualitative study regarding the challenges of science communicators in Ghana. Applying this approach allowed for a deeper understanding of the experiences of science communicators in Ghana. It also contributes to existing knowledge on the challenges of communicating science in developing countries by capturing local voices, their perceptions, and possible solutions. The application of phenomenological study and a pragmatist approach for this study are discussed in-depth in this chapter. The research plan, including the methodology, data collection, analysis, ethical concerns, the researcher, and study participants, are also highlighted in this chapter.

Research Questions

Gee posits that Discourse encompasses the saying, doing, being, valuing, and believing of a group of people. To have insights on the challenges of science communicators in Ghana based on these five factors, it was imperative to ask the following questions which to shed light on local Ghanaian voices and their lived experiences:

RQ1: What are science communicators' perceptions regarding the underlining challenges of science communication in Ghana?

RQ2: How do science communicators perceive local science communication interventions in Ghana?

Methods

A qualitative research approach is appropriate when the study focuses on how individuals perceive, experience, and make sense of the world. Creswell (2009) defines qualitative research as exploring and understanding the meaning individuals or groups ascribe to a social or human problem. Furthermore, according to Yilmaz (2013), qualitative research is an interpretive and naturalistic approach to studying people, cases, phenomena, social situations, and processes that

reveal in descriptive terms the meanings people attach to their experiences of the world (Yilmaz, 2013). This allows a researcher to dissect the meaning of an experience, both in terms of what was experienced and how it was experienced. On the other hand, pragmatism focuses on producing actionable knowledge, the interconnection between experiences, and ensuring that research is contextually relevant and informed by theory (Kelly & Cordeiro, 2020).

Kaushik and Walsh (2019) suggest that a pragmatist would identify genuine problems that are part of actual social situations, carefully define the problems, and then initiate the inquiry to address them depending on the purpose or objective of the inquiry. This study aimed to examine the experiences and perceptions of science communicators in Ghana, 'bracketing' their taken-for-granted assumptions and usual ways of perceiving their challenges (Lester, 1999); therefore, a qualitative research approach was the most appropriate choice. This method of inquiry unearthed detailed insights, contextual explanations, and interventions for the challenges currently faced by science communicators in Ghana.

The Researcher

The researcher has a Bachelor of Arts in Communication Studies and five years of experience working for nonprofit and government organizations. She has experience in corporate communications, supporting internal engagement, and external initiatives of those organizations. The researcher has been trained in the skills necessary to carry out the designed study with prior experience interviewing multiple people for a nonprofit specializing in science communication. The researcher's skills include interviewing and listening skills training as part of her bachelor's degree requirement at the Ghana Institute of Journalism (GIJ) and a qualitative research course at Kansas State University. No participant had a direct relationship with the researcher that represented a conflict of interest, such as a contract, reporting relationship, or any relationship with the researcher that may have influenced or imparted bias to the research study.

Study Participants

The sample was drawn from a population of science communicators of Ghanaian origin and currently domiciled in Ghana. These science communicators could be working full or part-time and had to be 18 years or older. These recruitment criteria ensured that the research study captured different perspectives on the conversation, identifying the challenges, gaps, and what needs to change to sustain science communication from the local context. Participants had to be fluent in English, but English did not have to be their native language. The target population was individuals engaged in communicating science-related information with the public, either with a background in journalism or a STEM-related field. Participants were recruited via a purposive convenience sample through the researcher's existing professional networks. The researcher reached out to her professional network via email, Facebook messenger, and WhatsApp and asked for leads that fit the criteria of potential participants. The researcher also contacted *STEM web (pseudonym), a nonprofit in Ghana focused on bridging the gap between the lab and the community through science communication. STEM web granted the researcher access and permission to post on its Science Communicators Fellows WhatsApp page with 28 members. The first point of contact with some participants was through WhatsApp or Facebook messenger. This was followed by an email with background information on the studies, a consent form, a request to respond with the signed consent form, and a time and date that suits their schedule for an interview. At the end of each interview, participants were encouraged to recommend colleagues that fit the criteria to participate in the research. The researcher anticipated approximately 10-20 participants for this study; however, 13 were interviewed.

Demographics of Sample Population

One must be a science communicator domiciled in Ghana to qualify for the study. Thirteen participants were interviewed for this study. Figure 1 indicates the participant demographics representing the minimum requirements described in Chapter 3.

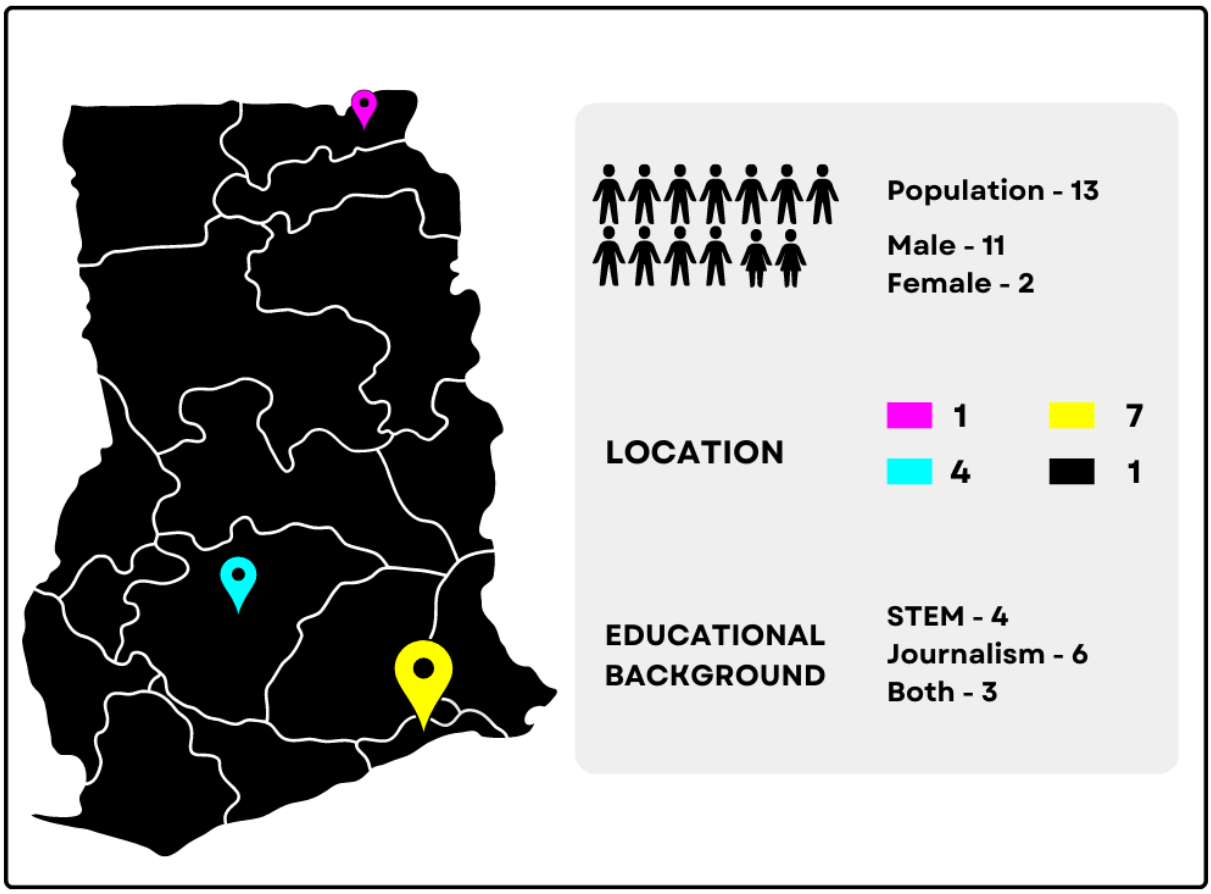

Figure 1 Demographics of Participants

All participants were science communicators domiciled in Ghana with a background either in journalism or a STEM-related field. All participants for this thesis were over 18 years of age; eleven identified as male and two as female. The data was collected from science communicators from different locations in Ghana. Out of the 13 participants, seven are based in Accra, 4 in Kumasi, and 1 participant in Bolgatanga, the Northern part of the country. Only one

participant could best be described as transient; they moved across regional borders within the country to engage with communities. The varying locations of the participants afford this study a unique opportunity of capturing the voices of locals from the southern and northern parts of the country.

Participants also had diverse educational backgrounds; 4 out of 13 had STEM-related degrees such as Electrical and Electronic Engineering, Nursing, Psychology, and Computer Science. 6 participants had an experience in Communication, Journalism, and Public Relations. In comparison, 3 participants had educational qualifications in STEM and Communication-related courses. Participants were fluent in English; however, there were instances where some statements were made in the local Ghanaian languages and slang on impulse. However, the researcher is fluent in two Ghanaian languages and conversant with most Ghanaian slang. Thus, this did not pose a challenge during transcription and coding. Table 1 shows the years distribution among the sample population. The years of experience as Science Communicators among the 13 participants ranged from 1 to 15 years. Participants with 5-10 years of experience represented 38.48% of the sample size, and participants with 1-5 years and 10-15 years of experience represented 30.76%, respectively. The wide span of experience, from one year to over a decade, allowed this study to capture beginners' perceived or lived experiences of experts in science communication residing in Ghana.

Table 1

Distribution of populations' years of experience

Years of experience	Frequency	Percentage
1-5	4	30.76%
5-10	5	38.48%
10-15	4	30.76%

Participants' Motivational factors, areas of concentration, and medium of communication

The participants' motivational factors, areas of concentration, and communication mediums were queried to understand better the sample population and the science communication landscape in Ghana. These three queries aimed to identify the motive or inspiration behind the participants' interest in science communication, the different fields or topics the sample covers, and the platforms used to engage the public. Figure 2 shows the diverse motivational factors of the sample science for engaging in science communication. Codes from participants' responses to the first query were imported into a word cloud generator, automatically producing words with high frequency in larger and bold font sizes. Based on this analysis, the dominant codes of participants' inspiration were related to passion, personal interest, social or community impact, intrinsic motivation, and science reportage missing in the media landscape.

Figure 2 Motivational factors of respondents for engaging in science communication.

Participants' responses were either connected to their aspiration for social impact or intrinsic, personal, or religious reasons for venturing into this field. Concerning the second query on areas of concentration, five areas were identified. The researcher used mind mapping to analyze participants' responses to the query. The topics or areas of interest were Health, Environment, Research Translation, STEM non-profit, and Innovative Solutions. Figure 3 shows the dominant areas of concentration and the specific topics the sample population engages their audience with.

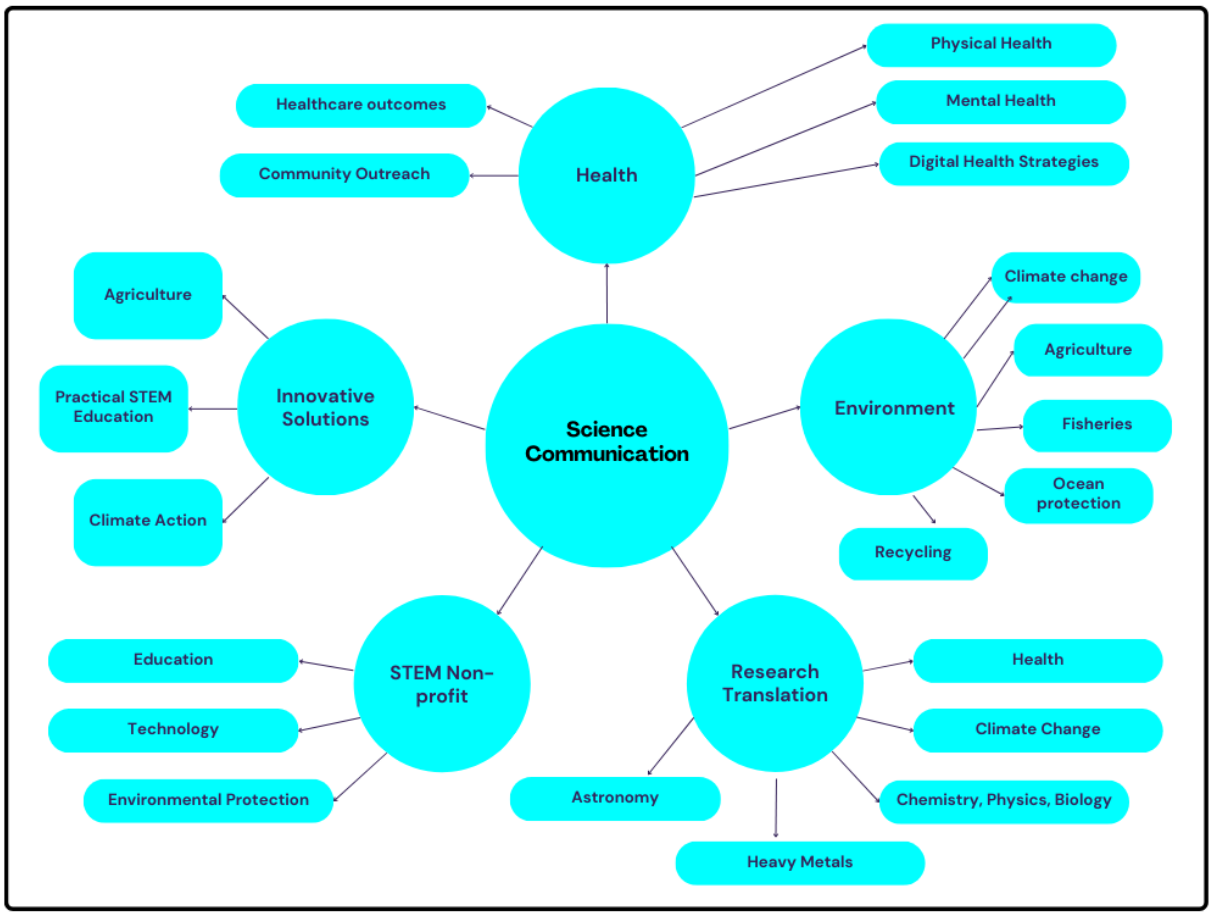

Figure 3 Participants' areas of interest for public engagement

Participants within the Health category communicate mental and physical health issues and the application of digital health strategies to achieve health outcomes within communities. The next category, environment, includes matters relating to climate change, agriculture, ocean

protection, and climate action, such as recycling. Other participants focus on translating scientific texts or research documents for public consumption. The next category highlights participants within the non-profit sector who communicate issues relating to science, education, technology, and environmental protection. These four categories were the dominant areas of concentration of participants with a journalism or communication background only, constituting 46.25% of the sample population. On the other hand, 15.29% of the sample population with both a journalism and STEM background had areas of concentration within the first four categories. The last category was Innovative Solutions, dominated by participants within an industry that makes technological products. Participants under this category have a STEM educational background, with one exception to the case, Participant 2, who is qualified in both communication and a STEM-related course. This makes up 38.46% of the population focused on communicating their innovations or technologies on agriculture, climate action, and practical STEM education to the public. Even though participants fit under specific emerging categories, some cut across. Based on further analysis from respondents using mind-mapping, nodes that dominate across the main categories were climate change, health, agriculture, environment, and technology.

Analysis of the participants' responses to the third query concerning their communication mediums suggests that 100 percent of the sample population use digital platforms like social media, blogs, and websites to engage with their audience (See Table 2).

Table 2

Participants' Mediums of communication

Medium	Percentage
Traditional Media	76.92%
Digital Platforms	100%
Physical Engagement	38.46%

Combination of Platforms	Percentage
Two mediums	76.92%
Three mediums	23.08%

Traditional platforms such as tv, radio, and newspapers are used by 76.92% of the sample populace, and 38.46% physically engage with their target audience through community and speaking engagements. Further analysis also indicates that all participants use multiple mediums; 76.92% use two mediums while 23.08% use three.

The aim of these three queries, motivation factor, area of concentration, and medium of communication, was to visualize the sample populations' inspiration for venturing into the field, the topics of discussion and the medium used to engage with their audience.

Data Collection

This study used an interviewing method where both the interviewer and the interview questions were the instruments for the study. This study applied in-depth interviews as a strategic qualitative methodology to capture the voices of local science communicators. Brinkmann (2018) describes an interview as "a face-to-face verbal exchange, in which one person, the interviewer, attempts to elicit information or expressions of opinion or belief from another person or persons" (p. 1000). The interviews provided an opportunity to develop a rapport with the participant, which is "excellent for not just providing information but for generating understanding as well" (Guest et al., 2013) of the phenomenon under study. In addition, a one-on-one interview also allowed the probing of participants' responses through follow-up

questions. The interviews began with open-ended questions about the participants' initial interest in science communication, and more intensive questions followed, with the intent to gather data on their challenges. The interview concluded with more open-ended questions, framed to invite more depth regarding possible interventions that could help revitalize science communication in Ghana. The interviews were conducted and recorded electronically on Zoom, a video conferencing software program with the option to record live transcripts to a cloud system. Live transcripts were then cleaned up for coding and analysis. The researcher's notes and reflections were used to capture research thoughts during and after each interview.

Interviews from 13 participants were transcribed and manually coded to capture the saying, doing, being, value, and beliefs (Gee, 1989) of science communicators in Ghana. After conducting the interviews on Zoom, live transcripts were cleaned up, coded, and analyzed, emphasizing the saying, doing, being, value, and beliefs (Gee, 1989) of science communicators that answered the research questions. The live transcripts of the interviews were manually cleaned with key phrases color-coded to make tracking and analysis easy. The color-coded phrases were transferred into an excel sheet and categorized under emerging coding categories. After the initial transfer of codes onto the excel sheet, cleaned transcripts from the interviews were further perused more deliberately to capture codes correlating with the emerging themes (LeGreco & Tracy, 2009).

Procedures Followed

Before the commencement of the study, the researcher submitted an ethical approval form to the Institutional Review Board of Kansas State University. After approval, recruitment began based on convenience and purposeful sampling. Recruitment of subjects commenced by tapping into an established network with Ghana's science and journalism community. Participants were recruited via email, Facebook messenger, and WhatsApp using a recruitment

script that provided all the required details about the study to make informed consent to engage with the research study. Interviews were recorded on Zoom after participants returned a signed informed consent form. Live transcripts were cleaned using audio recordings as a reference, and all forms of participant identification were removed and pseudonymized. The transcripts were then analyzed using LeGreco and Tracy's (2009) four-phased discourse tracing methodology exploring relevant themes from intersecting subject responses. These four phases include research design, data management, analysis, and evaluation.

Memo writing happened regularly throughout the study to flesh out ideas, concepts, patterns, and discursive moments noticed during interviews. Memos in this study included reflections, a summary of salient themes, codes, analysis, and the connections of themes or analysis to other participants. Reflection after interviews helped process and minimize bias "in relation to the research situation, participants, and data under study" (Birks et al., 2008, p.69), and it facilitated an understanding of the impact of the researcher's subjective influences on the collection and interpretation of data. Memo writing provided a means for noting down ideas, short key phrases, emerging concepts, theories, and interpretations and strategically sorting out data to make retrieving data more accessible. Memos also helped in tracking salient words or phrases and profound statements from interviews that could serve as vignettes to complement the documentation of the emerging themes. In addition, self-reflection and analysis of the data through memo writing helped the researcher develop an intense relationship with the data, enabling a heightened sensitivity to the meanings of the data collected.

Data Analysis

To analyze the data, the study applied discourse tracing, concerned with how a text's production is shaped, reproduced, and reshaped by social practices. It also pays particular attention to how discourse makes a practice appear routine and how it can provide an avenue for

change. In other words, focusing on concepts, statements, and ruptures that give form to a discourse. (LeGreco & Tracy, 2009). This study's first phase of discourse tracing involved developing a research design, defining the case, and reviewing relevant literature. Phase two was data management which required data collection that captured the micro (e.g., everyday talk and practices of science communicators), meso (e.g., organizational policies), and macro levels (e.g., cultural norms and social perceptions) of discourse to illuminate the discursive practices related to communicating science. This phase of the study also involved organizing the data for easy analysis.

The researcher also applied LeGreco & Tracy's (2009) technique for discourse tracing, which involved "an initial reading of data for emergent themes and codes, followed by a more systematic reading to lift out patterns" (p. 1522). Coding from the phenomenological approach was instrumental in centering the analysis on the participant's experience in a structured way. After conducting the interviews, live transcripts from Zoom were cleaned, coded, and analyzed, emphasizing the saying, doing, being, value, and beliefs (Gee, 1989) of science communicators in Ghana. The interview transcripts were coded in the order in which the interviews were conducted for the study. Coding was done in two stages. In the first stage, live transcripts were manually cleaned with key phrases color-coded to make tracking and analysis easy. The open codes were transferred into an excel sheet and categorized under emerging coding categories. Coding categories were developed based on the initial codes and their traced-out interrelationships (Kelly & Cordeiro, 2020; Punch, 2009), encapsulating interviewees' shared experiences (Birk & Mills, 2015). After the initial transfer of codes onto an excel sheet, the next stage of coding began. The cleaned transcripts were further perused more deliberately to capture codes and patterns correlating with the emerging themes or open codes that might have been missed during the first coding phase.

Phases three of LeGreco & Tracy's (2009) technique (analysis) and four (evaluation) then proceeded. Analysis began with the spreadsheet complemented by transcripts with color-coded vignettes to identify the emerging themes from participants (Birks & Mills, 2015).

Trustworthiness

Credibility, transferability, dependability, and confirmability are essential in establishing the trustworthiness of research (Lincoln & Guba, 1985). One of the ways to ensure credibility and transferability is to certify that those interviewed have the experience to discuss the phenomenon the researcher seeks to explore (Lincoln & Guba, 1985). For this study, participants were either STEM web Science Communicators Fellows or individuals from the researcher's professional network. All interviews were conducted and recorded on Zoom to prevent the researcher from adding or excluding any data from responses to guarantee the data's dependability. The author used exemplars and vignettes from the interviews to illustrate critical themes for this study, supporting the study's results. The use of discourse tracing and constant comparative analysis also ensured that the study demonstrated the links between the analysis and resulting theories. To ensure transferability, the researcher also wrote memos and self-reflections with thick descriptions of the phenomenon under study (Nowell et al., 2017). The study's dependability was enhanced using exemplars and vignettes from the interviews to represent multiple codes and provide context to the themes.

Ethical concerns

The risk to human subjects for this study was minimal, and all participants were above 18 years. Before submitting an ethical approval form to Kansas State University's Institutional Review Board, the researcher completed training on ethics and research on human subjects. After the board's approval, potential participants were emailed an informed consent form that followed the university's Institutional Review Board guidelines. The informed consent included

a brief on the purpose and process of the interview. In addition, interviews were transcribed with all forms of participant identification removed and pseudonymized. The names of the organizations they worked for were removed, and participants were assigned numerical identifiers based on the first alphabet of their first names. The data was stored on university computers in the Department of Communication Studies at Kansas State University, and only the researcher had access to the data. Once all recordings were transcribed and participants' information was anonymized, all recordings were immediately destroyed to minimize any future risks related to confidentiality.

Summary

The goal of this chapter was to outline the methodology used to answer the research questions. This chapter also discussed data collection and analysis; the procedure followed to demonstrate how the study was conducted, and who participated. Chapter 4 discusses the data findings, which respond to the research questions.

Chapter 4 - Results

This chapter summarizes data collection and the analysis to uncover codes and resonant moments from the study participants. The interpretation and presentation of data from this study include graphic representations that summarize the sample responses, followed by a discussion of the discursive moments from the interviews. Tables, graphics, mind maps, and vignettes are also featured in this chapter to emphasize resonant moments from interviews. These codes and themes are discussed to reveal how they tie into the research questions:

RQ1: What are science communicators' perceptions regarding the underlining challenges of science communication in Ghana?

RQ2: How do science communicators perceive local science communication interventions in Ghana?

While respondents were posed with different questions to unearth their perceived challenges and awareness of local interventions, their responses to the two questions were linked to the same discursive themes: (a) Funding and Resources (b) Audience (c) Motivation (d) Education and (e) Language. These themes are dynamic and multifaceted as they reveal different levels of challenges faced by science communicators in Ghana.

Table 3

Frequency of categories in response to RQ1

Category	Frequency
Funds & Resources	38
Audience	34
Motivation	24
Education	8
Language	3

The discursive themes resulted from open and selective coding of the data, followed by mind mapping to trace and understand their relationship. Table 3 shows the frequency of the emerging

themes from the transcripts. Based on the data analysis, codes relating to access to funds and resources were highly cited, followed closely by audience needs and priority. The motivation of journalists, scientists, and media houses also ranked highly in response to RQ1, with education and language the least ranked. Figure 4 shows the emerging discursive themes along with prominent vignettes of respondents' perceived challenges of communicating science in Ghana.

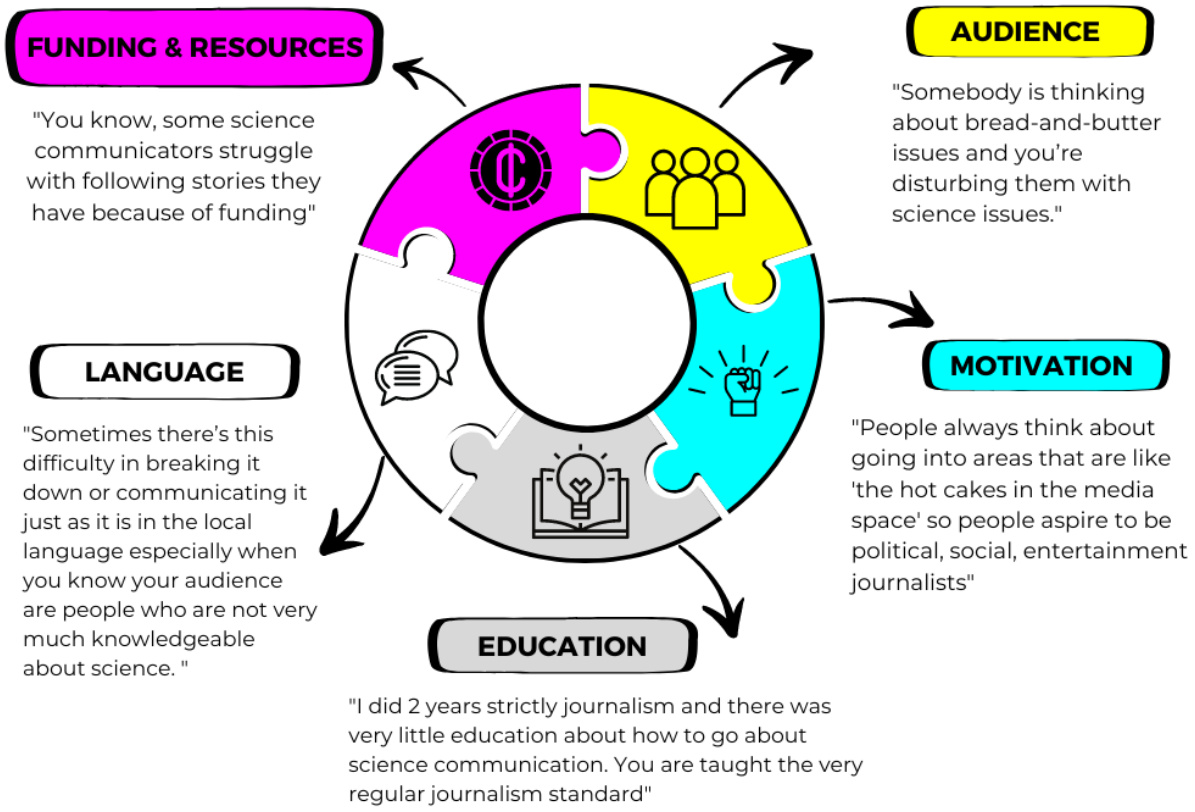

Figure 4 Emerging themes from data analysis

RQ1: What are science communicators' perceptions regarding the underlining challenges of science communication in Ghana?

Further investigation of these discursive themes revealed resonant moments or macro-level discourses for RQ1 and RQ2. For RQ1, the macro level discourses were: (a) science

communication as an economic luxury (b) culture, beliefs, and taboos as a filter for science communication, and (c) science communication as an enabler of systematic bias. The following section discusses the four macro-level discourses based on participants' responses to RQ1.

Science communication as an economic luxury

Ghana is a lower-middle-income country with an economy largely dependent on exports such as gold, cocoa, and in recent years oil (French, 2022). Before the outbreak of COVID-19, poverty was a common phenomenon in rural Ghana, with about 6.8 million of its population living in extreme poverty (Ghana Statistical Service, 2018). According to the World Bank, Ghana's poverty rate was estimated to have increased from 25% in 2019 to 25.5% in 2020 (World Bank, 2022), meaning approximately one in five Ghanaians lived below the national poverty line. The COVID-19 pandemic also impacted the country's economy, impeding efforts to address poverty and inequality. Reports from the International Monetary Fund (IMF) show expected economic growth and a recovery from the pandemic (Yeboah, 2021); however, Ghana continues to face challenges such as energy shortages, unemployment, inflation, external debt, and a large informal economy. Bultitude (2011) notes that it can be challenging for the public to appreciate science or research findings during economic hardship. For example, during the interviews, some participants (Participants 1, 3, 5, 11 and 12) confirmed that their target audience are in the informal sector; thus, they need to be approached strategically because their priority is to make a living. To put that into perspective, one participant, a healthcare worker who travels to different communities across the country, noted that when interacting with traders or market women, it is best to go to the market that way "you are not taking them out of there because they need to make money and they need to keep their family going" (Participant 11). He also emphasized that there are instances where their audience are apathetic towards their messages because they lack amenities like hospitals or community-based health care services to complement the application

of the information. Therefore, in such situations, the demand for facilities precedes appreciating the benefit or import of scientific information.

From the context of this study, discourse relating to science communication as an economic luxury encompasses factors such as the needs and priorities of the audience serving as a blindfold to science. This discursive moment also highlights respondents' perceived challenges of accessing funds to pursue science stories, the time and travel sometimes required to follow up on science stories, and adding expert voice to publications. Respondents also highlighted the difficulty of establishing trust and getting resource persons or experts to speak on science-related issues and Ghana's political architecture. This discursive theme had the highest number of codes underscoring the gravity of its impact on communicating science in Ghana. The following paragraphs discuss the aforementioned discursive themes with vignettes to expatiate the perceived challenge of science communication as an economic luxury.

Audience needs and priorities act as filters for scientific information

The findings suggest that the target audience of the sample population has needs and priorities, often related to their standard of living. These concerns rank higher in the hierarchy of their needs than listening to science stories. However, the iteration of most participants suggests that several science communicators recognize this concern. Participant 1, a journalist based in Accra with over a decade's experience in communicating science, notably stated that he does not fault people too much "because somebody is thinking about bread-and-butter issues, and you are disturbing them with science issues" (Participant 1). This statement shows that the economic hardship and inequality experienced by their target audience, though a challenge to achieving their communication campaigns, is not overlooked or ignored by science communicators. Participant 1's reference to 'bread and butter issues' indicates the complex priorities that

constitute economic and social barriers to accessing or appreciating scientific information in developing countries (Bultitude, 2011).

Communicating science requires access to funds and resources

A second aspect of science communication as an economic luxury explored across interviews is resources to pursue science stories. These resources comprise the money and time needed to investigate scientific findings and access experts to speak on authority about pertinent issues. 69.23% of the sample population indicated that these two factors impede their science communication efforts. Most science communicators' discourse on communicating issues relating to science in the newsroom was described as not being receptive. Existing studies contend that in some organizations, science reporting is typically handled by a general assignment reporter or wire services (Weigold, 2001). Weigold (2001) suggests that science reporters, compared to their general news peers, lack status in news organizations. General reporters are likely to be assigned to fast-breaking news stories relating to science. Our findings suggest that media houses do not go out of their way to train or help individuals in specific beats like science journalism. Unlike countries in other parts of the world, such as Europe, where there is some autonomy in science communication, institutions, and their policies regulate the direct provision of organizational resources, allocation of assignments, and deadlines (Trench & Bucchi, 2015). Thus, when the value placed on science communication is low in the newsrooms or within an organization, access to funds and strict deadlines hinders probing science stories. A journalist based in Accra with less than five years of experience within the field described the situation as frustrating as "it takes that energy away from you, and it makes it difficult for you to deliver your reports on time." She further notes that this challenge is shared by other colleagues within the field:

> Science communicators struggle with following some stories they have because of funding. From conversations we have had with other science communicators in my cohort, there is a lot of conversation around having stories they want to pursue, but funding is an issue (Participant 10).

Three respondents echoed that newsrooms look for stories that go out immediately, and stories that require a lot of travel or movement tend not to be picked up in the newsroom. Participant 6 described an experience while researching a science story, and their narrative highlights politics as a resonant discourse in science communication:

> If you want to undertake certain research or take a report, and it demands traveling, which means you need a company vehicle, and a lot of fuel is involved, you are likely not to advance. When I wanted to carry out a story on seashells, I had to sacrifice my funds to undertake that report. So that is how it is in the newsroom. The perception is unenthusiastic and lackadaisical because most of them are coming from humanities points and backgrounds. Moreover, they are used to politics and social stuff, which mainly does not involve science. The perception is more lackadaisical; they think it might not be so important (Participant 6).

The data extrapolate that general news stories are selected over science stories during pitch meetings in media houses because developing science stories takes much time. This data supports available studies which suggest that large media corporations and national newspapers tend to have the resource to cover in-depth science reports. However, small media broadcast stations do not have the time or money for in-depth science coverage (Weigold, 2001). In addition, because of their limits on time and resources, reporters “rely on routines that provide access to news such as press conferences, announcements, and scientific meetings” instead of engaging in an in-depth inquiry into issues relating to science (Weigold, 2001, p.167). Weigold

(2001) also suggests that news organizations engage in "inter-media agenda setting," where they heavily rely on each other for what is considered newsworthy. A subject's newsworthiness helps media houses gain more eyeballs and clicks. Discursive themes from this resonant moment project divergent views on science communication as an economic luxury. For instance, Participant 6, an editor at a private media house, notes that media houses also need to generate revenue. Thus, they are very particular about stories that do not generate revenue in the short term. News relating to politics or entertainment gets more views and clicks, and, as a result, science stories are relegated to the background. Another respondent from a state-owned media house who has been in the industry for over a decade noted that irrespective of the stance of media houses, many journalists tend to decide where they fit and where they have a passion (Participant 8). However, Participant 2 believed journalists prefer other areas considered "hotcakes" in mainstream media:

> I think one of the ways of promoting science communication is to get journalists involved. I belong to an extensive network of journalists, and when we were in school, people always thought about going into areas like "the hotcakes in the media space." People aspire to be political journalists, and they all want to go to the areas already blooming. You would hardly hear anybody saying, ' I am a journalist, and then after school, I want to go into science communication; I want to dedicate my career to communicating science.' So, there is a lack of interest; most journalists are not eyeing that area (Participant 2).

This resistance positioning places the onus on journalists or science communicators to take the initiative in communicating science rather than the dominantly referred 'lackadaisical' nature of media houses or institutions.

Scientists are hesitant to grant interviews due to trust

Another discursive theme from the texts was trust. The issue of establishing trust between journalists and scientists in Ghana and the hesitance of scientists to grant interviews was a dominant discursive moment within interviews. Respondents often described the scientific community as a 'niche group' or 'isolated community.' Participant 13, a journalist working for a state media house, explains that the absence of trust between most journalists and the science community is due to the actions of other journalists, which makes them reluctant to engage with journalists.

> I will say it is an issue of trust, especially when it comes to the science community. You want to interview a particular scientist, but they hesitate to talk to you. However, it also originates from the fact that some colleagues sometimes misrepresent what they interview people for. So, when you want to go to them, they are hesitant to open up to you; they are unwilling to grant you an interview because you may go and then misrepresent whatever they will tell you. So that is the issue (Participant 13).

Participant 10, a novice in the field, noted that some reports disinform the public to gain public reactions or views. The reports tend to be one-sided, providing reportage that gets people talking, sometimes disregarding the content or context of interviews with scientists to produce controversial headlines. She further laments that the implication of such acts serves as a deterrent to accessing resource person's expert opinion and completing science-related articles:

> Another area would be having enough people to speak to on the subject. You have to know a specific person before the person would even be willing to talk to you. They are committed to staying within their own small environment unless contacted by a person who is a veteran. But if you are a new journalist who wants to write about science, it is difficult to get someone to speak to you on the topic you want. I remember my report like this (sickle cell), I had to speak to a reporter who had spoken to another

> doctor, and that doctor gave me a contact who was in that field. So, at the end of the day, sometimes you feel demoralized. I just need this one thing, and I have to go through so many means to connect to a resource person. Not having resource people immediately to give you insights is a challenge (Participant 10).

Scholars such as Davies (2021) and Bubela et al. (2009) have documented that science communication plays an accountability role by maintaining public trust and protecting the public purse. However, prior literature also suggests that despite the apparent changes in science and the media system, available data do not indicate abrupt changes in the orientations of scientists toward the media and their patterns of interaction with journalists (Peters, 2013). Nonetheless, this study's findings indicate that attention should pivot toward establishing trust between scientists and journalists. As described by some participants, the struggle to connect with experts to speak to scientific issues is demoralizing and impedes their efforts. Science communication would therefore require collaboration between resource persons like scientists and journalists rather than being isolated from each other.

The last discursive theme under science communication as an economic luxury focuses on the political architecture in Ghana and the collaboration between the government and private institutions. Ghana practices a multi-party-political system with different parties and interest groups vying for power and influence. The country has a two-round voting system where an election is held every four years for a new President and members of parliament (Electoral Commission Ghana, n.d.). The political landscape is characterized by high political competition between two main parties, the New Patriotic Party (NPP) and the National Democratic Congress (NDC). Nonetheless, like many other African countries, Ghana's political landscape has challenges. There are concerns about corruption, and some have criticized the slow pace of development and the high level of inequality in the country (The Bertelsmann Stiftung, 2022).

Participant 1, an editor in a state-owned media house, evokes the political discourse intertwined with science communication as an economic luxury. The editor cites instant gratification as the impeding element that devalues science and its communication among Ghanaian politicians. The editor notes the tension between investment in science and politics, citing that "because the political calendar is four years, so, everybody comes and they want to do something at the surface level, kind of done in a lackadaisical manner, then they leave." He further adds:

> It does not have to be like that, nature issues are long-term. For instance, if we are restoring, restoration can take more than four years, and a politician would not want to invest in something that they will not see the benefit in the short term for people to see that they have done something (Participant 1).

Science communication as a subset of political discourse

Discourse by respondents on science communication as an economic luxury also portrays the tension between science communication and politics, which seeps its tentacles into other aspects of the Ghanaian economic landscape, influencing investment in education or training in science communication at universities and infrastructural development to improve healthcare outcomes. This discursive theme also captures the reactive response and bureaucracy of government institutions. Based on our findings, 53.85% of this study's respondents contend that even though there are communication universities in the country, science communication as a course or topic is absent from the basic to the tertiary level of education. One participant, a graduate of a university in the southern part of the country that specializes in communication, detailed their four years of experience at the university:

> What I have experienced or noticed is that there needs to be more education when it comes to science communication. I did two years of strictly journalism at YUIO (pseudonym) University, and there was very little education about how to go about

> science communication. You are taught the very regular journalism standard (Participant 10).

38.46% of the sample population cited education as a perceived challenge to their science communication efforts in Ghana. According to them, journalists and scientists need the training to acquire the requisite skill in communicating science to the public. Many universities in Ghana offering communication courses are public schools whose policies and curriculums are influenced by government decisions and funding. For instance, according to a study by Appiah and his colleagues in 2012, science journalism in Ghana was practiced by general journalists who typically need more training within the field. However, in the late 1980s, the Ghana Institute of Journalism offered courses on agricultural reporting, aviation reporting, and environmental reporting; however, they were halted in the 1990s when funding from Ghana's Ministry of Food and Agriculture and the Ghana Civil Aviation Authority ceased (Appiah et al., 2012). This once again underscores how science communication as an economic luxury negatively influences the efforts of science communicators in Ghana.

Partnerships and collaborations with government institutions

When asked about their perceived challenges in communicating science, participants with a STEM background had a different perspective regarding access to resources. For individuals within the private and non-profit sectors, partnerships or collaborations with government institutions are the most accessible means of reaching isolated or rural communities. Thus, bureaucratic positioning was evident from the analysis. Participant 11, a healthcare expert with over a decade's experience, often travels to different parts of the country to engage rural communities about their health. The healthcare expert asserts that even though the government does many checks before deciding on partnerships or collaborations, it often delays the efforts of people who want to take action:

> Sometimes when we want to do these community engagements by working through established institutions, like government institutions, it requires quite a lot of proceedings and bureaucracies, which delays whatever we want to do. We must remind the government that the provision of health is no provision at all if it is not communicated, or the provision of good sciences is to improve the health, lives, and people's well-being. It is not at all if it is not communicated effectively if it is not communicated right. We must task government institutions to be able to fulfill their mandate by funding and providing resources (Participant 11).

The health expert further positions science communication as an economic luxury from a different angle where the absence of certain facilities such as hospitals disrupts science communication efforts:

> At the point you are educating them, it may not even be that they do not need your education, but they need a facility to respond to or serve their sick child. So, the communication may not necessarily be about what must be done by them (the audience) but what must be put in place to ensure that when they take action, it will be complemented by the right institutions and resources (Participant 11).

Participant 11's discourse characterizes the slow pace of development and the high level of inequality in the country; however, as Guenther and Joubert (2017) succinctly state, these government often have to make daunting decisions about which areas of their economies requires urgent development or funding. Moreover, in most cases, decision-makers or governments in developing countries must make funding or policy decisions about science and technology, which require some degree of scientific literacy to ensure that wise decisions are made (Trench & Bucchi, 2015).

Science communication as an economic luxury comprises discursive projecting the value placed on science communication by the public, the media, the scientific community, and the government. As a participant aptly described, science communication is not a '*thing'* in Ghana. The findings, therefore, suggest that the low regard and optimism of science communication is shared by the public who have pressing needs and priorities; media houses who place prominence on stories that generate more views, clicks, and revenue; the dwindling trust between the journalism and science communities and finally, governments who have to choose which areas to invest in for their people's best interest.

Culture, beliefs, taboos, and misconceptions as a filter for science communication

Participants' discourse situates culture, myths, taboos, long-standing traditional ideologies, and misconceptions as a filter for science communication efforts. This resonant moment in respondents' discourse covers communities' existing ways of thinking, taboos, and beliefs and perceptions that influence their awareness of scientific knowledge or create misconceptions about science. The science communicators' knowledge of their audience, sensitives, and preconceived notions of the audience is also captured under this category. One hundred percent of the sample population mentioned at least one of these descriptors as a perceived challenge in communicating science to their target audience. For instance, the sample population suggests a culture of silence around certain topics or issues. This is evident in Participant 12's description of how phenomena that are beyond their target audience's comprehension are tagged as spiritual or supernatural:

> I discovered that there are certain issues people would not like talking about. And you know, in our part of the world, certain things that cannot be explained are seen as spiritual or supernatural phenomena. That was one major issue I realized in my quest to be a science communicator (Participant 12).

Existing studies show that misconceptions and myths in Ghana intercept strategies meant to improve healthcare outcomes. For instance, a study by Tabong and Segtub in 2021 shows that myths, misconceptions, and misinformation about COVID-19 in Ghana posed health risks to the younger generation. According to Tabong and Segtub, some of these misconceptions were that "the hot climate in Africa inhibited viral replication and transmission," followed by speculations and conjectures that "COVID-19 was being used as a biological weapon to target developed economics." (Tabong & Segtub, 2021, p.1). In the context of this thesis, Participant 11 notably captures the essence of how these elements hinder the intended healthcare outcomes of their patients:

> For example, because I work and engage with some communities on mental health, I understand why some of them would not want to seek help when it comes to mental health or get relatives or loved ones involved because they believe it is some punishment from the gods. So anybody dealing with them would be infected with the mental illness. Moreover, in such a situation, when you are dealing with clients or any person with a mental condition in the facility and family support that is very necessary at that time fails to come in, then you understand why that could be happening. So, suppose you have to engage, educate, or involve them. In that case, you will definitely have to be educated on how these cultural sensitivities border mental health, where people do not want to be associated with the afflicted. Nevertheless, you need to know what these misconceptions are to address them so that you can improve their healthcare (Participant 11).

Beyond the supernatural and spiritual discourse's impact on health outcomes, myths, and misconceptions also hinder the engagement and implementation of science. An example is Malawi, a country in East Africa where research findings indicate that misconceptions about

science hamper the implementation of research findings in rural areas where an exceptionally high burden of diseases affects the population (Nyirenda et al., 2018).

Preconceived notions about the target audience

Although not prevalent throughout the texts, participants' misconceptions about their target audience are also worth a brief mention. Participant 11, a science communicator in the health sector, shared a different stance about interacting with audiences whose culture, myths, or taboos hinder communicating science. According to Participant 11, the preconceived notions about specific communities or people from different backgrounds impede trust, community entry, and communication:

> Unfortunately, people do not even know how to connect with their audience, or they do not even know their audience at all; they move in and want to start educating. In my early days, I was like, ahh, how do you people not just understand this simple thing? You are just being difficult. However, they were not just being difficult– they have built their thoughts and understanding of this health crisis in a certain way, so you realize that they are not trying to be difficult; that is what they have lived to understand (Participant 11).

Audience's knowledge and appreciation of science

Another discursive theme evident in interviews was the positioning of the audience's awareness of the application of science and its boundaries. Two participants spoke in-depth about their audience's knowledge of science, its scope, and how it disrupts their messages. Their tone shows that this is a standard fixture that goes beyond the audience's needs and priorities but is a byproduct of how science is taught and learned in schools. In Ghanaian schools, science is taught as part of the integrated science curriculum, where students are introduced to the basic concepts of biology, chemistry, and physics at the basic level. These three subjects are later taught separately at the secondary and tertiary levels. Science should be taught and learned

through a combination of theoretical instruction and practical applications. The teaching of science starts at the basic level of education and extends up to the tertiary level. However, there is a balance between the two depending on which part of the country you find yourself in and the funding or resources available. Students in rural and urban areas face this challenge; however, rural areas have the worst-case scenario as they may have fewer resources and less access to the latest technology, making engaging in practical science education difficult. Much still needs to be done to ensure that rural areas can access quality practical science education. More funding and infrastructure are needed to educate, sensitize, and bridge the gap between theoretical knowledge and its application or implication in the real world. The education system must be revised to ensure equal opportunities for Ghanaians, regardless of location. The ripple effect of this imbalance is evident in the discourse of this thesis's respondents. For instance, Participant 2 explains how those he has encountered have a different interpretation of what science is, its scope or what could be considered as science, and as well the application of scientific knowledge:

> Generally, there is a limitation concerning what people think science is, as there is a lack of application of the boundaries of science. Sometimes when we talk about science, people expect science to be like the hard, physical, hardcore science– physics, biology, chemistry. But when you begin to talk about other areas that involve the application of scientific thinking, a whole different discipline on its own... we have had training on astronomy, and people are like, how is this part of science? There is this lack of appreciation of the boundaries of science. People are limited in their thinking of what science is (Participant 2).

This positioning is further built upon by an editor in one of the state-owned media houses who argues that the gap in knowledge about science, its application, and impact prevents their target audience from appreciating or caring about science:

> People really do not care about, for instance, filling wetlands to build homes; they say, 'why should we leave wetlands for migratory birds and other aquatic life while human beings need a place of abode to live.' So that understanding is still not there. People do not value nature, its services, and its ecosystem (Participant 1).

Their response shows that this discursive theme is also linked to the dominant discursive moment throughout the texts, science communication as an economic luxury. The needs, priorities, culture, misconceptions, and knowledge of the audience present tension, a cacophony where they must filter and choose between serving their needs and appreciating scientific knowledge. Participant 12's description of her audience's reaction to a recent publication paints a better picture of this tension:

> Very recently, there was a story I felt I had to put out, and then when I did (laughs), it did not get as much of a reaction as I had hoped. It had a few comments on it from people that were interested in it, and even with that, it was more of 'what are we supposed to do with this information?' (Participant 10).

In this section, I spoke about how participants positioned discourse around culture, myths, taboos, long-standing traditional ideologies, and misconceptions as a filter for science communication efforts. The findings strongly suggest evident tensions between the audience's beliefs, ways of thinking, and perceptions of what science is and its implication in their lives. The root of this tension can be traced to another dominant discursive moment, science communication as an economic luxury, which was discoursed extensively in the previous section. In the following paragraphs, I discuss the final dominant discourse in response to RQ1.

Science communication as an enabler of systematic bias

The last discursive moment from participants' response to RQ1 was science communication as an enabler of systematic bias. This discursive theme comprises translating science to local languages and scientists ending their research at publication. In the context of this paper, this category also documents respondents' perceived challenges associated with the content of messages, breaking down complex terminologies and jargon, and communicating via the native tongue of their target audience and English as the "universal language of science." These perceived challenges subtly perpetuate systematic bias as there is unequal access to scientific information and decision-making power due to the public's ignorance and prejudice about scientific knowledge in areas where supernatural or spiritual beliefs heavily influence the decision-making process. During discourse tracing, three codes were attributed to this category, making it the least ranked. However, respondents made profound statements about how it obstructs their communicative efforts.

Translating scientific terminologies and jargon to local languages

Ghana is a multilingual country with about 50 indigenous languages and English as the official language (Sadat & Kuwornu, 2017). Based on the 2021 census, 7.9 million Ghanaians cannot read or write in English (Ghana Statistical Service, 2022); thus, local languages are a primary means of communication. The findings of this paper suggest that participants and audience vary; they come from different cultures and speak different languages. Participant 12, who works in the non-profit sector, raised concern about the diverse languages of their target audience and how it stunts their efforts:

> Sometimes when you communicate with an audience, you realize that they come from different backgrounds with diverse languages. If you do not understand the language, it will be hard for you to communicate with them. And then certain words do not have local

> languages referring to them, so trying to get them to understand those particular phrases or words is very difficult because once they do not understand, and you cannot translate into the local languages, it becomes a barrier (Participant 12).

Communicating solely in English or translating into their language might be a challenge, especially when the target audience's language does not have words or phrases for scientific terminologies or jargon. English has established itself as the lingua franca for science, language of science, technology, media, and business (Bidlake, 2008; Gordin, 2015). While having English affords scientists access to global scientific literature, using English creates a barrier for non-English speakers. Having a "universal language of science" has allowed scientists to communicate ideas freely and gain access to global scientific literature; the primary use of a single language has created barriers for those who are non-native English speakers.

Participant 2, who engages their target audience, mostly the general public through programs on local tv stations, underscored the strain of translating scientific terminologies to local languages:

> One of the main challenges has been the language barrier. For most of the concepts in science, there has not been that deliberate attempt to localize them. So, for instance, two weeks ago, I was on VVVV (pseudonym) TV talking about an innovation challenge we are trying to do. And then, I had to explain plastic parallelism. VVVV TV is a local tv station that speaks Twi, the local language. And here I was; I did not know how to explain plastic parallelism using the local language. So that has been one of the main challenges because science, STEM is very technical and involves a lot of jargon. Sometimes there is difficulty breaking it down or communicating it just as it is in the local language, especially when you know your audience is not very knowledgeable about science (Participant 2).

The linguistic barrier between scientists and the public

Previous literature contends that "scientific discourse carried out in the native language of a target audience yields greater participation, motivation, and optimism, and leads to stronger connections to concepts in the native culture" (Márquez &. Porras, 2020). This paper substantiates the argument for using native languages; however, findings underscore the absence of local words and phrases for scientific terminologies and jargon within specific geographical contexts like Ghana. A journalist provided a different viewpoint about language as a barrier to communicating science. He hints that scientists do not know how to communicate or translate their findings to people outside their profession:

> Sometimes, even the experts or scientists you are talking with cannot explain it well. I remember there was this work on the profiling of Vitamin D in rheumatoid arthritis...so after reading the paper, I wanted to engage the scientists on it for him to explain it to me. And there was a lot of back and forth trying to find a better anecdote to explain or an analogy to make it easier to understand. After I was done with the work, the scientist said it had become too layman. For instance, when you use certain analogies or comparisons to paint a mental picture for the audience, they will tell you that all the science is gone; it has become too layman (Participant 6).

Scientists end their research at publication

Respondents also situate discourse around the perceived indifference by journalists, media houses, and researchers in Ghana towards communicating science. 61.53% of the sample population cited minimal motivation or interest in science journalism as a challenge to communicating science in Ghana. For some participants, the onus was on researchers to communicate their work to the public instead of ending their studies at the publication stage.

> There is a lot of research but usually, researchers stop at journaling, they are not implemented. Moreover, reading journals and books at this age is very hard for people.

> Even if they pick up journals and books, it is about things that are primarily of interest to them, and many people are not really interested in reading about science and science communication. I think researchers should do a lot more than publish. The more we put out scientific information, the more the public sees it, the more the public hears about it, the more they discuss it, and the more they get interested in knowing about science (Participant 11).

Training scientists to communicate their findings

In 1941, radical British scientist J. B. S. Haldane offered advice to his colleagues, which is still relevant today. Haldane reflects that 'Popular science can be of real value by emphasizing the unity of human knowledge and endeavor, at their best. This fact is hardly stressed at all in the ordinary teaching of science.' (Trench & Bucchi, 2015, p.6). He asserts that scientists could learn from writing popular science, an interpretation of science intended for a general audience, rather than for other scientists as they train within their fields of study. Other scholars such as Ndlovu et al. (2016) also emphasize this gap in training as some scientists do not know how to communicate with their audience or who their audience is. These researchers indicate that the appropriate science communication training could help academics overcome some of these barriers to public discourse about science. Participant 11 shifts the focus of the conversation onto scientists and researchers, indicating that it is incumbent on them to have the requisite skill in communicating their research not only to journalists but to the public.

> At times, you find people who are health professionals, but they do not have the right capacity in terms of communicating or engaging with people or educating them or addressing health challenges (Participant 11).

Beyond the absence of the requisite skills in translating science, science communicators also face the hurdle of communicating to audiences from diverse backgrounds with different languages.

Márquez and Porras, in their study on science communication in multiple languages deduce that "scientific discourse carried out in the native language of a target audience yields greater participation, motivation, and optimism, and leads to stronger connections to concepts in the native culture" (Márquez & Porras, 2020, p.2). However, there are barriers to publishing and communicating scientific findings in native languages. According to their findings, some of them include (a) the pressure of publishing findings in globally recognized English journals to yield more citations, (b) ingrained systematic biases within larger institutional bodies (tenure track requirements, expectations from grant agencies), and finally (c) financial pressures in newsrooms. These barriers limit the creation of rich scientific data in the native language of researchers, and it intercepts the transfer of knowledge to communities that may benefit from it, further widening social and scientific inequalities worldwide.

Summary

The dominant discourse moments from this thesis present a mixed bag of discursive themes such as the content of messages, translation to local languages, and global recognition of English as the language of science. The absence of attributes for scientific terms and jargon in specific local languages, the hesitance of local scientists in moving beyond publication to engage the public with their findings, institutional and organizational policies (tenure, grants) that kowtow foreign scholars to publish in the 'universal language of science' to ensure citations and foreign recognition. These elements come together to subtly perpetuate systematic bias where scientific findings are communicated in a foreign language barely understood by the masses within certain geographical contexts whose lives will be impacted by decisions made about science and technology. This section discussed the findings from the sample population's response to RQ:1: What are science communicators' perceptions regarding the underlining challenges of science communication in Ghana? After discourse analysis, three dominant

moments emerged: (a) science communication as an economic luxury (b) culture, beliefs, and taboos as a filter for science communication and (c) science communication as an enabler of systematic bias. The subsequent section discusses the findings of participants' responses to RQ2.

RQ2: How do science communicators perceive local science communication interventions in Ghana?

Discourse analysis of the sample populations' response to RQ2 suggests that their awareness of local interventions is related to five discursive themes: (a) Education (b) Funds and Resources (c) Audience (d) Language and (e) Motivation. Based on analyzing participants' responses to RQ1, funding and resources were the highest-ranked perceived challenge. However, their response to RQ2 shows Education as the highest-ranked intervention proposed by participants. The highest-ranked intervention was Education, followed by funds and resources, audience, language, and motivation. Table 4 shows the frequency of codes attributed to each category or theme.

Table 4

Participants' response to RQ2

Category	Frequency
Education	26
Funds and Resources	14
Audience	9
Language	7
Motivation	3

Even though the data shows that most challenges are connected to the audience, sample responses also indicate that science communicators and institutions must take the initiative to promote science communication in Ghana. Further analysis of the five discursive themes reveals one resonant discursive moment: science communication as a collaborative effort towards development. In the subsequent paragraphs, I discuss in detail this dominant position invoked by participants' responses to RQ2.

Science communication as a collaborative effort

Effective science communication can promote growth and development in developing countries. Existing studies show that public engagement in scientific knowledge can foster a culture of innovation, inspire new ideas for researchers, and influence decisions by policymakers that impact economies. Public engagement and awareness of science also play a role in promoting health outcomes in developing countries. A public more informed about science, its application, and its impact on their livelihood can also influence their decisions and activities that impact the environment. Based on the participants' responses, local science communication interventions in Ghana are discursively positioned as science communication as a collaborative effort that involves stakeholders such as scientists, media, STEM-based organizations, and policymakers. From the context of this study, discourse relating to science communication as a collaborative effort encompasses discursive themes such as education and training of science communicators, audience-focused content, and translation of scientific findings. This discursive moment also highlights the provision of resources and collaboration between scientists and communicators to facilitate effective science communication.

Education and training of science communicators

In this study, respondents emphasized education as their third highest-ranked challenge; however, when asked about interventions, it ranked first among the sample population. Throughout most interviews, participants focused on science pedagogy and the availability of science communication courses in schools from the basic to the tertiary level. They emphasize the teaching and learning of science at the basic level through art and play. This entails training journalists and scientists with the requisite skill to communicate with their audience. Participant 10 elaborates further on what could be done:

> Basic training, there should be more science communication training in the various communication schools in the country. There are many communication schools but there is no module for teaching science communication, and I think we want to train the next generation of science communicators and writers, we need to start right at a very early stage in their education, and that would grow the interest in science communication (Participant 10).

Overall, participants felt education was an essential intervention to their perceived challenges. Nonetheless, the content of a science communication program would require further research considering existing data already suggest views from the developed world on what "constitutes a good science communication program may not be relevant in the developing world, where people's priorities are very different and where they often face a complex mix of infrastructural, economic, educational and social barriers in terms of accessing scientific information" (Guenther & Joubert, 2017, p.17). During analysis, several ways of discursively recasting education and training resurfaced. This positioning brought to light the impact of the motivation or interest of journalists, scientists in science communication, sensitization of the public, and the provision of infrastructure by the government to complement the training. To pique the interest of journalists and scientists in writing more science stories, two participants suggest persistent sensitization and deliberate education at a young age:

> One way we can achieve that is to intensify or create outreach programs through some of these training institutions that produce journalists. But we have to, as they say, catch them young and use art and performance to create interest in science at the foundational level. We also have to design programs to advance this course to reach these student journalists to make sure that right in school; their minds are directed to this whole agenda so that right after coming out of school, they know that this is a field that I can explore so let me probably go into science communication (Participant 2).

Creation of audience-focused content

The deficit model of science communication cites education of the audience as a means of raising awareness of science (Bauer, Allum, & Miller, 2007); however, based on the findings of this study, science communicators need to probe the needs, beliefs, culture, and misconceptions of their audience before engaging them. The audience is the end user of the information shared by science communicators; thus, 38.46% of the participants suggest it is important to know who they are, their cultural sensitives, and their misconceptions about science and taboos. A participant within the health sector explains that considering all these, including the geographical location, will aid in creating better communication strategies to build trust and achieve the proper health outcomes.

> Geographical location also borders on the culture of the people, the language of the people, and even myths and misconceptions about health subjects that are being considered. When you want to go to certain communities for certain conversations, you know that certain taboos and cultural sensitivities must be considered. Hence, it would be best to address all these things before crafting or developing health communication strategies to address a health crisis (Participant 10).

Participant 10's discourse suggests the incorporation of audience analysis which equips journalists and scientists with the proper knowledge on communicating and translating science to the public, who are often outside their field. Participant 10 further reiterated the relevance of training scientists and journalists in communicating science to assuage the prevalence of misinformation and disinformation:

> There is still a lot of misinformation and disinformation about topics that are science related. And there are also a lot of areas in science that are under-reported in Ghana. So, it is vital that in the next five years, we grow the passion for science communication,

> especially for journalists and writers and young communicators who are coming up (Participant 10).

By considering the audience, their needs, and backgrounds, communicating science to the public could have an immense implication on policies, public health, and scientific literacy. While education is crucial, respondents also positioned training within the field as a personal choice. Education can expose journalists and scientists to science communication; one cannot force them to like a specific job or career. 61.53% of the sample population positioned motivation or little interest in science journalism as a challenge to communicating science in Ghana. According to the participants, educating children about science through basic art education and performance will create awareness and interest in communicating science at an early age.

> It should start from basic education, where science can be communicated through art, plays, and stuff like that; it will create an easier route to science communication for kids, young people, and even activists (Participant 2).

A journalist with a background in STEM proposed the creation of science desks in media houses, research institutions, and universities to communicate and disseminate science to the public. This will reduce the frustration of accessing resources or expert opinion and sustain the motivation of those already in the field. Another respondent explained that the presence of science desks in newsrooms could elicit the interest of mainstream journalists.

> If we have science desks set up in the universities, then it means that journalists in Ghana get access to research works. For instance, if I want to research, I can go to ResearchGate or a university's repositories to find out what they are doing, which is tough. But if you have those desks there, then it is easy (Participant 6).

The present findings clearly indicate that most science communicators in Ghana who engage in this field have either interest-driven or career-driven motivations. Motivation or

interest in science communication by journalists, scientists, and media houses is crucial in promoting science. The findings suggest that these three factors can promote or inhibit science communication efforts in Ghana. Interest from journalists could help build capacity within the field. Scientist interest in translating science could assuage the challenge of accessing expert opinions for science stories. Considerations from media houses could lead to creating science desks to help disseminate scientific knowledge to the public. Without interest from these three groups, interventions suggested by this study might not yield positive results. However, as previously stated, interest or passion cannot be forced, one has to be sensitized about the field, but they have to make a choice.

Translating scientific terminologies and jargons to local languages

Beyond interest from scientists, discourse on collaboration also centered on consideration of the audience's language and educational level while translating scientific knowledge. The reasoning behind this consideration, according to the study's participants, was to ensure the relatability of the message in a simple and clear form. According to one participant, ignoring this could hinder the translation of science:

> So usually, when people do not understand, their engagement is very low, so that is where you have to break it down and make it very simple so that people can understand. Science people like using big, big words that people cannot understand. It is like if you want to use the big words, then talk among yourselves. But then, if you are putting stuff out there, you should write it as if you are writing it for the kind of people within your social media network, which would usually not be scientifically inclined people (Participant 9).

As an intervention towards the perceived challenge of translating scientific terms into local languages, Participant 2 asserts it might take a long time to achieve this, considering the variety

of languages spoken in the country. The respondent also suggests it is a possible long-term solution that would require commitment, a collaboration between stakeholders, and a change in educational policy:

> We have to look at it from the top–down. Government must make deliberate efforts, on the part of policymakers, and the Ministry of Education, to see how feasible that can be and what kind of resources or what kind of commitment we need to put in investing to make this possible. If we want to create an alternative to teaching science in the local language, achieving that would take quite some time. It is a long-term plan; it cannot happen overnight, like next year or the next two years (Participant 2).

Translating scientific jargon and terminologies into local languages, as stated by Participant 2, would require a lot of commitment and time. Márquez and Porras (2020) also relay similar sentiments on this, underscoring that in developing countries, many communities do not have the educational tools and financial resources to implement such changes. However, they recommend that the onus falls on scientific journals and traditional media to translate research into other languages. Participant 11, however, places the responsibility on scientists to communicate their findings with the public.

> We have made these findings, presented our paper, and published that is the end. It looks like we are scared of even promoting our findings, and we leave it to journalists or other people to report them. When we can break the message down and use strategies that can relate to the people. For example, in Kintampo, when we engage with market women, we have to use activities that relate to them to make the conversation and communication lighter and simpler. So, we went directly to the market, and we did not take them out because they needed to make money and keep their family going. So, you get to them directly, and while we engage with them, we let some people perform choreography and

> music to demonstrate the message that is being said so, or that we have found out, or whatever we want to tell people to do or to do so, we need to break down (Participant 11).

This discursive moment also ties into a prominent discursive moment in response to RQ1, science communication as an economic luxury. To effectively implement some of these recommended interventions, the findings also show the need for collaboration between scientists, communicators, and policymakers in translating and communicating science to the public:

> I think it would also fall between the scientists and then even the journalists themselves. So, we must bridge the gap between journalists and scientists and even between policymakers. We must bridge the gap between these two because sometimes scientists do not know how to communicate. You speak with someone, a scientist, and the technicalities and terms are difficult for your audience to grasp. As a journalist, you have to play a role by finding a better means to communicate with your audience. The scientists will also have to learn how to communicate because I think they are not so forthcoming because they do not know how to communicate their findings to journalists or even people, so most of them are not so forthcoming (Participant 5).

Another intervention based on the sample populations' response is using multiple mediums for diverse groups. According to respondents, there are direct and indirect ways of reaching the target audience. However, the audience needs to be considered before making a choice, and multiple mediums could be applied to achieving one's goal:

> I think another way is to use a suitable medium to engage the people. So, if you know you are speaking to, for instance, market women, you should know that you should not put any information on social media because it is hard for them to go on social media to get their news. So, you should find the appropriate medium for the appropriate target

> audience. And when we go to these communities, where the language is a barrier, we should try and find other science communicators who speak that language so that they can be a medium between the people and us so that communication is not misunderstood (Participant 12).

The findings from this study suggest that 100% of the respondents use digital mediums in communicating with their audience. In early 2023, there were 23.05 million internet users in Ghana, representing 68.2% of the population (Kemp, 2023). In terms of digital platforms, WhatsApp, followed by Facebook, is the most preferred social media platform (Sasu, 2022). Despite the growth of digital technologies and increasing internet access in Ghana, approximately 13.8 million of the country's population lives in rural areas with unstable access to the internet (Sasu, 2023). Thus, reliance on digital platforms only might not be the best route to reaching an audience within such contexts. Applying social media might be a justifiable recommendation in certain contexts; however, based on the study's findings, combining traditional media, digital platforms, or public engagement might be the best approach. The findings show that 76.92% of participants use two mediums, while 23.08% use three mediums. Therefore, individuals engaging in science communication campaigns need to consider a combination of traditional and digital modes along with physical engagements.

Summary

Based on the findings, science communicators in Ghana recognize the role of educating and training journalists and scientists with the right skill set in communicating science. Respondents frequently cited the need for collaboration between the media, scientists, and policymakers in communicating science to the public. This chapter provided a discussion of the findings for RQ1 and RQ2. This section also covered the interpretations and presentation of data which incorporated tables, mind-maps, graphics, and vignettes to complement the presentation of the

findings. For RQ1, the macro level discourses were: (a) science communication as an economic luxury (b) culture, beliefs, and taboos as a filter for science communication and (c) science communication as an enabler of systematic bias. Responding to RQ2, participants' discourse was positioned around one dominant discursive moment of science communication as a collaborative effort. From the context of this study, discourse relating to science communication as a collaborative effort which encompasses discursive themes such as education and training of science communicators, audience-focused content, translation of scientific findings, and collaboration between scientists and communicators. In the next chapter, a summary of the findings is provided, followed by a short discussion on the implications of the study, its limitations, and recommendation for research.

Chapter 5 - Discussion and Conclusion

This chapter summarizes the research results, followed by a discussion of key findings and its implication for the field. The chapter concludes with the study's limitations and recommendations for future research. This paper aimed to determine the perceived challenges of communicating science and the perception of local intervention relating to science communication in Ghana. The study posed two questions to achieve this goal:

RQ1: What are science communicators' perceptions regarding the underlining challenges of science communication in Ghana?

RQ2: How do science communicators perceive local science communication interventions in Ghana?

Key findings of the study

This paper contributes to existing studies on science communication research from different societies and cultural contexts (Ndlovu et al., 2016; Nyirenda et al., 2018; Trench & Bucchi, 2015). The findings of this investigation shed light on the status of science communication in developing countries like Ghana. It provides insights and recommendations for the practice that could be applied to other countries in similar contexts or situations. It also reinforces the need to consider the target of science communication efforts as distinct groups with different cultures, languages, priorities, and educational backgrounds, which influence their perception and reception of scientific information. The study applied discourse analysis to answer these questions to capture the perceived challenges of science communicators' domicile in Ghana. While respondents were posed with different questions to unearth their perceived challenges and awareness of local interventions, their responses to the two questions were linked to five discursive themes: (a) Funding and Resources (b) Audience (c) Motivation (d) Education, and (e) Language. They were all related to the target audience of science communicators, the

journalism and STEM community, media houses, or government institutions. Further investigation revealed three dominant discursive moments for RQ1 and one dominant moment for RQ2. These discursive moments from the findings are dynamic and multifaceted as they demonstrate different challenges science communicators face in Ghana and their proposed interventions. In the next section, I provide a summary of the results for RQ1 and RQ2.

RQ1: What are science communicators' perceptions regarding the underlining challenges of science communication in Ghana

After conducting the discourse analysis, three dominant moments emerged for RQ1: (a) science communication as an economical luxury (b) culture, beliefs, and taboos as a filter for science communication, and (c) science communication as an enabler of systematic bias. The findings suggest that the target audience in developing countries has needs and priorities, which sometimes act as a filter against appreciating scientific findings (Bultitude, 2011). One of the significant descriptors cited in the findings was also related to cultural sensitivities. Based on data from this thesis, science communicators in Ghana propose considering an audience's culture, myths, taboos, and long-standing ideologies during community entry. This will allow science communicators the opportunity to know more about their audience to craft messages that are relatable to them.

Previous studies on science communication and culture contend that culture reinforces the ways of seeing the world; therefore, "science communication must pay attention to culture and the corresponding different ways of looking at the world" (Medin & Bang, 2013, p. 13621). The findings from this paper align with this assertion and underscore that a target audience's culture, beliefs, and values cannot be separated or ignored during the exchange of information. Because culture is the lens through which most people view the world, make sense of it, and reinforce their thinking and beliefs, it is vital to demonstrate cultural sensitivity. This is

especially salient when communicating complex information, such as science, to communities in developing countries where phenomena beyond the target audience's comprehension can be tagged as spiritual or supernatural.

These dominant discourse moments present a mixed bag of discursive themes, such as the needs and priorities of the target audience, the content of messages, translation to local languages, and global recognition of English as the language of science. Other discursive themes also focused on the absence of attributes for scientific terms and jargon in specific local languages, the hesitance of local scientists in moving beyond publication to engage the public with their findings, and finally, institutional and organizational policies (tenure, grants policies) that kowtow foreign scholars to publish in the 'universal language of science' to ensure citations and foreign recognition. These elements combine to subtly perpetuate systematic bias where scientific findings are communicated in a foreign language barely understood by the masses within specific geographical contexts whose lives will be impacted by decisions made about science and technology. This section discusses the findings from the sample population's response to RQ1, and the subsequent paragraph discusses the key findings of participants' responses to RQ2.

RQ2: How do science communicators perceive local science communication interventions in Ghana?

Responding to RQ2, participants' discourse focused on one dominant moment of science communication as a collaborative effort. Based on the findings of this thesis, local science communication interventions in Ghana would require the active involvement of stakeholders such as scientists, media, STEM-based organizations, and policymakers. This discursive moment also highlights the much-needed collaboration between scientists, communicators, and policymakers to facilitate effective science communication and the provision of resources to

complement their effort. Implementing this intervention would require the training of scientists and journalists, the consideration of the target audience's cultural and educational background, and finally, the translation of scientific findings.

Contributions of the Thesis

This paper contributes to science communication research in different forms. First, the study supplements existing knowledge and application of discourse analysis as a method of qualitative enquiry. It also contributes to existing scholarship on science communication models and theories in describing the status or practice of science communication within low-to-middle-income countries. Furthermore, it provides recommendations based on the lived experiences of science communicators that could be considered when communicating scientific knowledge to an audience within a similar context as Ghana. Previous studies have pushed the boundaries of research in communicating science from different perspectives and contexts. In what follows, I discuss the implication to a larger population beyond the studied sample. This section also includes this study's methodological and theoretical contribution of this study and the practical applications of the study.

Methodological Contribution

The researcher used a study design appropriate for investigating the research question to capture diverse responses from the studied population. During the research process, the researcher identified five salient moments where the study design complemented the research process. First, using semi-structured interview questions provided the avenue to build rapport with the participants and ask follow-up questions that captured their lived experiences to generate a better understanding of the research question. The reiteration of confidentiality, the purpose of the study, and the option to opt-out at any given time during the interview helped set the tone and expectations at the beginning of the interviews.

Next, using purposive convenience sampling and snowball sampling was a cost-effective means of recruiting participants. For scholars lacking grants or funding for their research, it can be cost-effective to tap into their professional network when recruiting; however, it can be time-consuming and restrictive when deadlines must be met. The application of this methodology also elucidates the importance of understanding the history, culture, and language of the target being studied. Having at least one member of a research team with background knowledge of the sample population helps decode responses couched within specific local contexts that individuals outside those settings or situations might overlook, ignore or underestimate their repercussions on the issue understudy.

Contribution of discourse analysis to this study

The application of discourse analysis reveals underlying assumptions, values, identities, tensions and dominant discourses that shape cultural and social discourse in Ghana. Discourse analysis in this thesis uncovers the beliefs and values that shape their appreciation of scientific knowledge. It also helps us to understand the tensions between the needs and priorities of the public, their awareness of the scope of science, and the application of scientific knowledge in improving their standard of living. Furthermore, finally, discourse analysis of the lived experience of science communicators in Ghana helped identify the infiltration or positioning of supernatural or spiritual perspectives in dominant voices and perspectives in cultural and social discourses in Ghana and their influence on the reception of scientific knowledge.

Generalizability of research findings

Qualitative studies require a minimum sample size of 12 to reach data saturation (Vasileiou et al., 2018, citing Clarke & Braun, 2013). Therefore, a sample of 13 was deemed sufficient for this qualitative study. Specific characteristics of Ghana as a lower-middle-income country, an economy largely dependent on agriculture, a large informal sector, and 90 ethnic

groups with unique languages and cultural traditions makes the country a unique area of study. The sample size also deems it fit to generalize the findings in understanding the challenges of communicating science to similar populations, settings, or contexts, especially in developing countries.

Theoretical benefits of the study

The findings of this thesis strongly suggest that the practice of science communication in Ghana is tilted towards the deficit model of science communication, where communicators attribute public skepticism or hostility to science and technology to a lack of understanding resulting from a lack of information. Thus, most of their efforts are geared toward repeating information to increase public awareness. The public's lack of information can be traced to their focus on fulfilling their needs and priorities, which shifts their attention from appreciating, pursuing and accessing scientific information. Further probing of this challenge also reveals drawbacks caused by the scarcity of resources, the slow pace of development and the high level of economic inequality influenced by policies, funding decisions and the agenda of governments (Guenther & Joubert, 2017; Ndlovu et al., 2016; Trench & Bucchi, 2010).

Despite the evolving nature of communicating science in different geographical contexts, the deficit model has remained the most prominent view of communicating science, presenting a public deficiency in knowledge, attitude, and trust (Bauer, Allum, & Miller, 2007). In 2007, Bauer, Allum, & Miller's critique of the model highlighted the shortfall of scientific institutions and expert actors who harbor prejudices about an ignorant public. This approach relays information that remains true to science's tenets, yet it often comes off as emotionless (Kappel & Holmen, 2019). Instead of delivering messages that often come off as emotionless, science communicators can remain faithful to the principles or tenets of their practice by moving away

from viewing the audience as passive in a one-way communication process (Kappel & Holmen, 2019).

Based on their response to RQ2, science communicators' proposed interventions suggest they recognize the deficit in communicating to their target audience. Their discourse on what could be done differently is centered around knowing the audience's needs, culture, taboos, and misconceptions to create relatable and easy-to-grasp messages. The findings also hint at recognizing that the audience is not a passive receiver of information, being conscious of the preconceived notions of their audience and choosing the suitable mediums, and making adjustments to their messages based on what they know about their audience. In short, the findings of this thesis reinforce the notion that the deficit model of science communication is an archaic model that makes assumptions of the public without further probe. The response to RQ2 also reaffirms the delivery of scientific information by centering on the audience's needs and attitudes and applying different communication approaches to build relationships with the public through community entry and dialogue. This approach to communicating science would expose diverse "views, values, experiences, and concerns from the audience with the intention to learn with and from each other" (Reincke et al., 2020, p.2).

Practical Applications of the study and its contribution to society

Existing studies highlight several recommendations for promoting science communication. For instance, scholars like Salmon and Roop (2019) provide insight into the need for training, resources, and structures for strategic engagement in science communication. This thesis adds another layer to this recommendation– a careful consideration of the audience's needs, priorities, language, and the motivation of journalists and scientists to engage in the field. The knowledge and appreciation of science differ in different geographical locations. As indicated by the findings of this study, the audience has needs and priorities that are often related

to their standard of living. It also highlights the implications of culture, taboos, and misconceptions that do not align with the scientific consensus. Thus, appreciation of science and efforts in communicating them in a developing country like Ghana requires audience analysis to meet their needs and achieve the goals of science communication campaigns. Another factor is language and how specific scientific terminologies and jargon do not have attributes within the local language, which makes translating science difficult.

In other parts of the world, such as Europe, the research contributes to an agenda of science in society, and science communication is professionally autonomous and relatively independent of government. This data suggests that the situation is different in Ghana (Trench & Bucchi, 2015). These findings show that partnerships and government allocation of funds or resources mediate access to health, education, and infrastructure, influencing the public's perception and values of science. Despite these challenges, this paper shows that science communicators in Ghana are self-motivated, driven by their passion and desire to make an impact. However, from their perspective, more could be done to improve the field, and this would require interventions that consider (a) Funding and Resources (b) Audience (c) Motivation (d) Education, and (e) Language.

This thesis also recommends a more participatory or dialogue approach to communicating science, a collaborative effort that involves science communicators from diverse fields of study and partnerships between governments, science communicators, and non-profit institutions. It also involves (a) the training of science communicators with the right skills, (b) the consideration of the relevance of messages to the intended audience, (c) the needs, priorities, cultural and educational background of the target audience, (d) the translation of scientific knowledge to local dialects, and (e) the provision of resources by governments (health facilities, revamped curriculums at public schools) to complement the efforts of science communicators.

Beyond these recommendations, a previous study by Bauer et al. (2007) asserts that a better understanding of the public's understanding of science would require a diagnosis of institutional neurosis. This paper adds another layer to this recommendation, contending that science communication must be considered an economic luxury in specific geographical contexts where it wrestles for the resources of governments who have to make tough decisions on which needs or priorities of their people requires immediate attention. A further look into the relationship between science communication and institution could clarify what specific elements wrestle for institutions' and governments' attention and resources to suppress the appreciation of scientific knowledge and its communication to the public. In the following paragraphs, I discuss the limitations of this thesis and identify research questions for further exploration that could inform future research directions in science communication research.

Limitations and Recommendations

Two significant limitations of this study could be addressed in future research. First, the population understudy is hard to reach. Science communication as described by one of the respondents, "is not a thing in Ghana"; therefore, access to individuals that communicate science to the public, either with a STEM or journalism background, was limited. The study aimed for 10-20 participants for the in-depth interviews; however, 13 people were interviewed for the study. The sample requirements could have been broader to allow the participation of individuals with science communication experience in Ghana but not domicile in the country of focus. This would have allowed us to interview science communicators, multinational organizations, or non-profits outside Ghana with prior experience engaging Ghanaians with science. This would have provided rich insights on this subject matter from a more diverse sampling pool. However, the sample requirement indicated in the study design restricted the researcher. Due to this,

opportunities exist for other researchers to examine the perceived challenges of communicating science using a less restrictive sample requirement.

Another limitation of the study was time. Unfortunately, this current work is not comprehensive as initially envisioned, and it falls short of extensively discussing all the emerging discourses due to time constraints. However, the findings from this thesis provide opportunities to unpack the complex challenges presented by communicating science within different contexts. For instance, future work could examine the translation of science into multiple languages to create simple and relatable messages for target audiences.

Conclusion

This research represents the application of discourse analysis for understanding science communicators' perceived challenges and how they perceive local science communication interventions in Ghana. To provide more insights, this thesis asked these two research questions:
RQ1: What are science communicators' perceptions regarding the underlining challenges of science communication in Ghana?
RQ2: How do science communicators perceive local science communication interventions in Ghana?

During the first phase of analysis, five dominant codes were found in response to the two-research question: (a)Education (b) Funds and Resources (c) Audience (d) Language and (e) Motivation. Further analysis of these codes revealed three dominant discursive moments for RQ1: (a) science communication as an economic luxury (b) culture, beliefs, and taboos as a filter for science communication and (c) science communication as an enabler of systematic bias. For RQ2, participants' discourse focused on one dominant moment of science communication as a collaborative effort. The findings suggest that the target audience in developing countries has needs and priorities, such as making a living, which sometimes acts as a filter against

appreciating scientific findings (Bultitude, 2011). In other words, science communication in Ghana and similar contexts around the world must consider: (a) audience needs, priorities and culture need to be considered before engagement with scientific information (b) messages need to be simple and relatable for the audience, preferably in their local languages (c) interest of journalists, scientists, and media houses should be sparked to increase capacity within the science communication field (d) science communicators need to be equipped with the requisite skills in communicating and translating science, (e) media houses need to place more value on communicating science, collaboration, and trust needs between journalists and scientists to allow easy access to information, and (e). The analysis indicates that the perceived challenges of science communicators are intertwined with their recommended interventions.

The application of discourse analysis in this thesis reveals underlying assumptions, values, identities, tensions and dominant discourses that shape cultural and social discourse in Ghana and their influence on the reception of scientific knowledge. Certain features of the country, such as its economic standing, diverse culture, multilingual people, and large informal sector, afford the findings of this study the unique affordance of applying the findings to other populations with similar settings or situations. Findings from this thesis also provide avenues for further exploration in science communication research in developing countries, such as the content of science communication courses or institutional neurosis that suppresses the appreciation of scientific knowledge and its communication.

Science communication is a medium for promoting scientific knowledge across the world. For developing countries like Ghana, it is a means of ensuring equal access to scientific knowledge, a platform for encouraging public engagement with science, an audience-centered approach to public policies development and a platform for improving quality of life and health. However, for science communication to effectively serve as a catalyst for public debate and

decision-making, it would require the consideration of the cultural traditions, taboos, misconceptions and priorities of the people. Findings from this thesis show the immense influence of these factors, which filters the perceptions and actions of the public when addressing public health concerns such as COVID-19. It is, therefore, incumbent on science communicators and researchers to couch their engagement based on the unique context or situation of their target audience rather than a one size fits all approach.

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Appendix A - Institutional Review Board Approval Letter

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Sean Eddington

Communication Studies

Manhattan, KS 66506

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 05/02/2022

Proposal Number IRB-11105

RE: Approval of Proposal Entitled, “Demystifying Science: Insights on the challenges of science communication in Ghana.”

The Committee on Research Involving Human Subjects has reviewed your proposal and has granted full approval. This proposal is **approved for three years from the date of this correspondence.**

APPROVAL DATE: 05/02/2022 EXPIRATION DATE: 05/01/2025

In giving its approval, the Committee has determined that: No more than minimal risk to subjects

This approval applies only to the proposal currently on file as written. Any change or modification affecting human subjects must be approved by the IRB prior to implementation. All approved proposals are subject to continuing review, which may include the examination of records connected with the project. Announced post-approval monitoring may be performed during the course of this approval period by URCO staff. Injuries, unanticipated problems or adverse events involving risk to subjects or to others must be reported immediately to the Chair of the IRB and / or the URCO.

Electronically signed by Rick Scheidt on 05/02/2022 10:52 AM ET

Appendix B - Informed Consent Form

PROJECT TITLE:

Demystifying Science: Insights on the challenges of science communication in Ghana

PROJECT APPROVAL DATE:	5/02/2022	**PROJECT EXPIRATION DATE:**	5/01/2025	**LENGTH OF STUDY:**	3 years

PRINCIPAL INVESTIGATOR: Sean Eddington

CO-INVESTIGATOR(S): Wilhelmina Antwi (wantwi@ksu.edu)

CONTACT DETAILS FOR PROBLEMS/QUESTIONS: Contact Sean Eddington at seaneddington@ksu.edu

IRB CHAIR CONTACT INFORMATION: Lisa Rubin, Chair, Committee on Research Involving Human Subjects, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, (785) 532-3224; Brad Woods, Associate Vice President for Research Compliance, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, (785) 532-3224.

PURPOSE OF THE RESEARCH:

This study examines the underlying challenges of communicating science in Ghana, a country in West Africa.

PROCEDURES OR METHODS TO BE USED:

For this study, you will be asked to participate in semi-structured interviews. These questions are mostly comprised of questions and prompts related to various aspects of communicating science, the challenges, and possible solutions to mitigating those issues. The interview sessions will be audio recorded for transcription purposes only. The estimated time required to complete each interview is approximately 30 to 60 minutes.

Your participation in this study is voluntary. You may choose not to participate or, if you agree to participate, you can withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitle.

RISKS OR DISCOMFORTS ANTICIPATED:

The risks associated with participating in this study are no more than what you would encounter in everyday life.

BENEFITS ANTICPATED:

You understand that participating in this study involves no direct benefits to you; however, the goal of this study is to develop findings that may shed light on how science communication is practiced in developing countries, the challenges and possible solutions from a non-western perspective. These findings may provide complimentary understanding from diverse voices, further advancing communication scholarship on developing countries. Therefore, there may be some indirect benefits associated with participating in this study.

EXTENT OF CONFIDENTIALITY:

You understand that if you participate in this study, we will use a randomly generated pseudonym as a way to identify your responses for data analysis. E-mail addresses will also be collected and used for potentially inviting you to participate in follow-up interviews. You also understand that, although rare, possibilities for a breach in confidentiality exist. However, there are safeguards in place to minimize the possibilities of such breach. Contact information will be stored in a secure database accessible only by the principal investigators and research personnel. Audio recordings will also be stored in a secure database accessible only by the principal investigators and research personnel. Once all recordings have been transcribed and all participant information have been anonymized (identifying information removed), all audio recordings will be immediately destroyed. This project's research records may be reviewed by departments at Kansas State University responsible for regulatory and research oversight.

The information that will be collected as part of this research could be used for future research studies or distributed to other investigators for future research studies without additional informed consent.

IS COMPENSATION OR MEDICAL TREATMENT AVAILABLE IF INJURY OCCURS? ☐ Yes ☒ No

PARENTAL APPROVAL FOR MINORS:

PARENT/GUARDIAN APPROVAL SIGNATURE: _____ **DATE:** _____

Terms of participation: I understand this project is research, and that my participation is voluntary. I also understand that if I decide to participate in this study, I may withdraw my consent at any time and stop participating at any time without explanation, penalty, or loss of benefits, or academic standing to which I may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form, and willingly agree to participate in this study under the terms described, and that my signature acknowledges that I have received a signed and dated copy of this consent form.

(Remember that it is a requirement for the P.I. to maintain a signed and dated copy of the same consent form signed and kept by the participant).

PARTICIPANT NAME: _____

PARTICIPANT SIGNATURE: _____ **DATE:** _____

WITNESS TO SIGNATURE: (PROJECT STAFF) _____ **DATE:** _____

Appendix C - Interview Protocol

Interview Protocol

Demystifying Science: Insights on the challenges of science communication in Ghana

Wilhelmina Antwi

Department of Communication Studies

Kansas State University

During the Interview:

Rapport-building:

- Tell me about how you got involved in Science Communication.
  - What inspired you to get involved in Science Communication?
  - Who encouraged you to focus on communicating science?
- Which media house/organization do you currently work for?
  - Who/What encouraged you to work for this media house/organization?
  - Tell me about the general perception of science-related content coverage by your fellow journalists/colleagues at your current workplace.

Science Communication

- What does the term "science communication" mean to you? In your own words, how would you define it?
- What specific area of science communication do you participate in?
- Tell me about the mediums/approach you use to communicate with your audience.
- How do you use your platform as a science communicator to enact change or social impact?
- What factors do you consider when engaging in a science communication endeavor?

Public Expressions of Science Communication

- How would you describe Ghana's reception to sharing scientific-related information on mainstream media such as you work for?
- What sorts of responses have you experienced from the public when communicating scientific information?

- What approach (broadcast, dialogue, etc.) did you use, and how was the reception?

Organized efforts

- Do you know of any associations or groups championing science communication in Ghana?
- Have you contacted them or engaged in any collaborative efforts toward communicating science communication?

Challenges

- What challenges do you face as a science communicator in Ghana?
- Are there other underlining issues that lead to the instability of science communication in Ghana?

Recommendations and Intervention

- What interventions would you recommend for establishing a sustainable practice of science communication?

Clearinghouse Probe: Is there anything else that you would like to cover? Do you have any comments about science communication in Ghana that I have yet to ask, or you would like to talk about?