# SCIENCE COMMUNICATION: A PANACEA FOR ADDRESSING GENDER-GAP IN NIGERIA'S STEM EDUCATION

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*ABSTRACT*

*There is a major concern about the prevalence of the gender gap in Science, Technology, Engineering and Math (STEM) education in some developing countries. Thus, this study examined the existing communication interventions for disseminating information about STEM to women and girls in two universities in Nigeria. It leveraged Roger's 1962 diffusion of innovations theory. The qualitative method was used, where fifty-six respondents from departments of computer science, engineering and mathematics, were examined to determine their extent of exposure to STEM-related information and their communication preferences for STEM-related messages. Results suggest that the majority of the respondents receive stem information through the mass media of which newspapers and magazinesranked highest. Accordingly, the majority of them would prefer personalized face-to-face communication and social media. The study recommended that change agents should be involved in the door–to–door campaign on STEM education.*

*KEYWORDS*

*Gender gap, Nigeria, panacea, science communication, STEM education*

## 1. INTRODUCTION

Goal four (4) of the Sustainable Development Goals (SDGs) promises to ensure quality and equitable education aimed at promoting lifelong learning opportunities for all by 2030. Goal five (5) pertains to gender equality and empowerment of all women and girls and goal seventeen (17) which advocates partnership and cooperation of all complements goal one (1) by emphasizing the need for equity and collaboration.

Although higher in ratio when compared to other countries, the underrepresentation of women in STEM is not peculiar to Nigeria. As reported by the Women in Global Science and Technology WIGSAT (2010), women are lacking access to professional and income opportunities leading to a decline in women's STEM participation in the United States ( WIGSAT, 2010; Omoniyi, 2019). Omoniyi (2019) noted that a study conducted by the Organization for Women in Science for Developing World (OWSD) and the Women in Global Science and Technology (WIGSAT) which was funded by the 2010 Elsevier Foundation Grant demonstrated that many countries are undermining the importance of allowing women to participate in STEM to effect positive national transformation.

In the same vein, there is a prevalence of gender gap in Science, Technology, Engineering and Math (STEM) education in some developing countries. Data from the Academy of Sciences for the Developing World (TWAS) has shown that Africa is lagging in terms of generating novel scientific knowledge because it contributes only 1.7% and majorly from South Africa, Algeria and Nigeria, while Korea contributes 1.6 times that sum (Dutta & Batta, 2013; Joubert, 2009). Similarly, Kaloostian & Chhetri (2021), in their comparative study of education, found "inequities" in information and communication technologies between the United States and Liberia. This is causing major concern in recent times because of the important place STEM holds in the overall development of nations, especially for nations who crave relevance in this fourth industrial revolution.

According to Odey (2012), for science to contribute to development in Nigeria in this competitive world that is knowledge-driven, commitment to science communication is relevant. Thus, several efforts have been made to encourage women's participation in STEM in Nigeria, several organizations that include the Nigerian Association of Women Scientists (NAWS), the Nigerian Association of Women in Science, Technology and Mathematics (NAWSTM), Gender Studies Association of Nigeria (GSAN) among others have been established to up women's participation in science and technology, yet there is still a prevalent disequilibrium (a representation of below fifty percent (50%) in STEM disciplines in many institutions in Nigeria, with more under-representation in Engineering and Veterinary Medicine (Omoniyi, 2019). Omoniyi further noted that the prevailing pattern of enrolment was evident in the recruitment of academic staff in Engineering and Veterinary Medicine, thus leading to the absence of role models who are females.

## 2. Statement of the Problem

Over the years, scholars have expressed a lot of concern over the underrepresentation of women in STEM and have called for the need to increase their participation (Nosek et al. 2009; Steele et al., 2002; Kane & Mertz, 2012; Mandina, Mashingaidze & Mafuta 2013). In Nigeria, science communication using the mainstream media and the internet exists; however, the extent to which science communication has contributed to the growth or otherwise of science has not been empirically determined (Dutta & Batta, 2013). Besides, the controversies in science which also lead to underrepresentation exist because all the possible "paths of communication between science and society" have not been exhausted (Tipaldo, 2013).

Prior research has concentrated on the causes of females' underrepresentation in STEM. For example, Jacobs, et al,(2005), Watts(2007), Asimeng-Boahene (2007), Thomas & O'Grady (2009) Karimi and Venkatesan (2009) and Omoniyi (2019). The common thread that runs through their findings is that the causes of low gender representation in STEM are cultural stereotypes, environmental setting parents' attitudes, teachers' attitudes and girls'/women's anxiety about science. Among all propositions for improving women's participation in STEM, the need to debunk myths, gender and cultural biases was prominent for example, scholars like Steele (2002), Kane (2012) Mandina et al. (2013) and Omoniyi (2019). Mandina, Mashingaidze, & Mafuta (2013, p.189) noted that: "Teachers and parents should de-emphasize gender and cultural biases attached to mathematics." Also, Stout, Dasgupta, & Hunsinger (2010) have proposed the use of "in-group experts" to enhance women's participation. Pritchard, (2006) suggested the need for role models and mentors while Omoniyi (2019) noted a need for an enlightenment campaign where parents would be sensitized on the need to keep their female children in school instead of giving them out in marriage at an unripe age. All these underscore the role of communication in entrenching attitudinal change in STEM education and occupation.

Against the backdrop of the absence of a comprehensive science communication practice in Nigeria as observed by Dutta & Batta (2013) the current study's purpose is to ascertain the extent to which communication has been employed to bridge the gender gap in STEM education in Nigeria, albeit through the lenses of four science-based departments in two Universities.

## 3. AIM AND OBJECTIVES

This study aims to examine the existing communication approaches to disseminating information about STEM to female students and teachers at the University of Port Harcourt and Rivers State University. The specific objectives were as follows: To

1) Establish the sources of information about STEM for females in the University of Port Harcourt and the University of Science and Technology, Port Harcourt
2) To ascertain the communication preferences of the females of the University of Port Harcourt and the Rivers State University of Science & Technology about STEM.
3) To find out the factors impeding STEM education among females at the University of Port Harcourt and the Rivers State University of Science and Technology, Port Harcourt.

### 3.1. Research Questions

1 What are the sources of information about STEM to females in the University of Port Harcourt and the Rivers State University of Science and Technology, Port Harcourt?

2 What are the communication preferences of the females of the University of Port Harcourt and the Rivers State University of Science & Technology about STEM?

3 What are the factors impeding STEM education among females in the University of Port Harcourt and the Rivers State University of Science and Technology, Port Harcourt?

## 4. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

The diffusion of innovations theory propounded by Rogers in 1962 guided this study. The theory explains how innovation spreads through societies and cultures. It assumes that four factors determine the acceptance of a novel idea. Those factors are the innovation itself, communication channels, time, and the social system (Rogers, 2003). Rogers defines an innovation to mean "an idea, practice, or project that is perceived as new by an individual or other units of adoption" (p.12). Communication channels are the outlets that facilitate the transference of ideas and which serve as the basic prerequisite for communication (Ghoshal & Bartlett, 1988; Rogers, 2003). Time refers to the time frame needed for adoption to take place (Ryan & Gross, 1943; Rogers, 1983) and the social system is the nexus of internal and external influences like mass media, interpersonal relationships and other factors that can affect a possible adopter (Rogers, 1983; Greenhalgh etal., 2004). Other factors that can affect the rate of innovation diffusion are education, the rate of rural versus urban population and the level of industrialisation.

How innovations are communicated to different parts of society and the subjective opinions associated with the innovations are important factors in how quickly diffusion or spread occurs. This is important to understand when developing science communication. Thus, Rogers (2003) in his theory further noted five categories of adopters. The first group is referred to as the innovators (individuals risk bearers at the forefront of testing the innovation). Second, the early adopters (those are individuals who utilise innovation and promote its usage in society). Third, the early majority (The early majority paves the way for use of innovation within mainstream society and is part of the general population). Fourth, the late majority (individuals who emulate the early majority in adopting an innovation making it part of a routine). Lastly, the Laggards (These are individuals who are afraid of taking risks they are the last group to adopt an innovation having been pressured by the overwhelming popularity of an innovation). Research has proven the heterogeneous nature of scientific communication audiences as evident in their tastes, features and preferences in media usage (Tipaldo, 2013).

The theory has been tested on many innovative ideas involving the spread of acceptance of novel practices that border on health, agriculture and even technology. The diffusion of innovations theory fits into the current study's context because gender is a key demographic factor in deciding science communication. In other words, it is assumed that gender is a significant factor in the intention to consume scientific information. It provides theoretical guidance Empirical studies have demonstrated provide the best way of disseminating information about STEM to females can guide strategic dissemination

Science Communication and Literacy

Science communication has evolved over three decades as a multidisciplinary intellectual field that involves mass communication, science education, social studies, museum studies and other scientific activities that are academic and professional (Trench &Bucchi, 2010). Even in mass communication, risk and health communications are closely related to science communication (Dutta & Batta, 2013). It is the act or practice of sharing information about science-related topics with the intention of education and awareness creation. For Science communication to be effective, communicators can be trained to leverage some of the methods employed by artists (Grushkin, 2010). Such techniques include entertainment and persuasion which encompasses humour, storytelling and metaphors (Lulu, 2008; Randy, 2009).

According to scholars like Thomas & Durant (1987) and Dutta & Batta (2013) science communication is imperative to improving science literacy. For instance, Thomas & Durant (2017) argued that science communication aids the understanding of science, generates support for scientific research or study, and influences political and ethical thinking and/or decision-making about science. In contrast, a public's lack of understanding of science can lead to "denialism" as seen in climate change denials (Randy, 2009). Besides, when only a minute proportion is knowledgeable about science and technology in a democracy, there is a deficit in scientific discourses which in turn negatively impacts policymaking. Issues like energy, climate change, evolution and disease prevention require scientific knowledge (Kennedy & Overholser, 2010).

Krulwich in his (2008) speech entitled "Tell me a story" argues that scientists have many opportunities to inform the public about interesting scientific works and such opportunities should be utilized as they ought not to be ignored. He argues that telling the success stories and struggles of science helps convey the authentic reality of science and scientists in contrast to self-opinions. For Science communication to be effective, communicators can be trained to leverage some of the methods employed by artists (Grushkin, 2010). Such techniques include entertainment and persuasion including humour, storytelling and metaphors (Randy, 2009; Lulu, 2008; Grushkin, 2010). He suggests further that scientists must resist shunning the public and those metaphors should be used to explain the complex phenomenon in science. Some scientific information is perceived to be sensational depending on the knowledge and experience of its popularisers. Certain science popularisers share the same goal as celebrities; they crave to be famous (Forbes, 2017). A study has shown that readers' understanding of science news can be swayed by the comments of a dissenting few as seen in the case of Popsi.com, comments as a significant forum for discussions on science research and policy (Walsh,2015).

Science Communication Arsenals

Several communication opportunities are available in science communication depending on the willingness of a country to harness and/or invest in them (Bultitude, 2011; Dutta & Batta, 2013) such communication arsenals include mainstream journalism, live or face-to-face activities and online interaction (Bultitude, 2011). In the same vein, Tipaldo (2013) argues that there are majorly two major channels for communicating science and which are "direct and media-related channels" (p.97) and he observed further that the efforts have to aim at improving the penetration of the direct media because their power is yet to be appreciated.

## 4.1. Mainstream Media

Traditional media are newspapers, magazines, television and radio. They are the media that are advantageous in reaching large heterogeneous audiences. They were popularly used in disseminating scientific information in the past (Bultitude, 2011; Ipsos-MORI, 2011). As noted by Bultitute (2011) the mainstream media are an outlet for quality news about science because they are made up of professionals who can set an agenda to influence the government's policies in science. However, the mainstream media have been criticized as being inadequate for science information dissemination because they often portray science as being difficult and mysterious (Tipaldo citing Einsiedel, 1992) and they are not dialogic and are known for reducing the scope within which science can be comprehended because of other competing information culminating into misleading media coverage and misrepresentation (Bucchi, 2006; Ipsos-MORI, 2011; McCartney; 2016) and somewhat frictions, frustrations and counter-accusations between journalists and scientists (McCartney; 2016).

## 4.2. Live or Face-to-Face Activities

This category refers to direct and authoritative sources that are employed in producing and promoting knowledge of science (Tipaldo, 2013). The category is made up of all interactional activities which include public lectures in museums or universities, debates, science busking (a form of science street performance, where science is used to draw in a crowd and explain a topic to them), sci-art exhibits, Science Cafés and science festivals, scientific research done by professionals and nonprofessionals done in face-to-face contexts (Illingworth, 2017; SciArt Initiative, 2019). This method is useful in giving scientific information in an entertaining way (Bultitude, 2011). Through personal communication, professional and non-professional scientists can interact. Thus comedies and festivals can be used to pass scientific information since studies have shown that individuals seek entertaining scientific information (Shiju, 2017). This form of engagement is dialogic and it gives room for content control, however, it is limited in reach, expensive and may attract only audiences that have a preexisting interest in science (Bultitude,2011).

## 4.3. Internet and Science Communication

If the mass media have been accused of engendering negative attitudes about science, is the internet helping to popularize science by changing such attitudes? There is a divergent opinions regarding the use of online communication arsenals for scientific communication. Some feel they are inappropriate as they serve as a distraction to the serious activities carried out in science and that they serve as an outlet for misinformation. The "failure of science-focused social networking sites such as Scientist Solutions, SciLinks, Epernicus, 2collab and Nature Network" buttresses such perspective. However, owing to changes in science education or outreach and changes in interactional patterns among scientists themselves, others are leveraging online platforms for scientific activities (Ramasubbu, 2016; Carry, Jeffrey & Amy, 2017). Although unrecognized by many, research has shown that the internet and social media are potentially important in discussing scientific topics with diverse audiences as they can serve as a "public voice for science" (Ramasubbu, 2016; Collins, Shiffman& Rock,2016).). Studies have shown that different points of view can be communicated to different audiences using Twitter because it is advantageous in influencing the number of times an article can be cited. The articles with more tweets were found to have a greater likelihood of being cited than those with fewer tweets (Shaughnessy, 2012). Still, a study by Tipaldo (2013) demonstrated that the internet was most trusted for science communication in Italy and men were the major users of science-based content on the internet, while women prefer science movies and theme parks. In the same vein, a study found that the majority of the scientist surveyed in America use Google Scholar, Research Gate and LinkedIn to communicate science with their peers (Burt, 2014).

Several factors are limiting the willingness of scientists to go online. The unwillingness of some scientists to make their works available online is because of labels like Sagan effects (disparity between a scientist's popularity and the quality and quantity of his work) or Kardashian Index (a measure of discrepancy between a scientist's social media profile and publication record). Fear of flouting the Ingelfinger rule (The policy of considering a manuscript for publication only if its substance has not been submitted or reported elsewhere.).Such unwillingness, in turn, has led to the birthing of a movement like "open science," which calls for the need to make science more accessible (Burt, 2014).

# 5. METHODOLOGY

## 5.1. Research Design

This study employed the qualitative approach where focus group discussions were used to generate data. Eight focus group sessions comprising seven participants each were held in the two Universities studied.

## 5.2. Sampling

To investigate the topic of science communication among female students in two Nigeria Universities (the University of Port Harcourt and Rivers State University of Science & Technology) snowball sampling technique was employed in recruiting fifty-six focus group participants. The eligibility criteria included being 18 years old or above, and being a female in any of the science disciplines offered by the two universities.

The first research question sought to know the prevailing sources of scientific information among female students. The specific aim was to know the present channels of science communication. We found that presently, information is being accessed in newspapers as some newspapers have a column for science and technology. One said, "We all know that it is only men that buy newspapers, I only read about science when occasionally going through my father's newspaper." Another one corroborated and said, "I don't know of any television programme about science and technology. No communication outlet that encourages women to study science."

Our second research question considered the communication preferences of the female scientists in the two universities studied. We found that the majority of the discussants preferred getting scientific information through face-to-face communication. A respondent said science is a serious business; its information is best understood in a face-to-face context. Another person corroborated her by saying, “I am a girl, I do not buy newspapers, I expect science information through scientific activities like workshops, seminars and conferences. But such opportunities are rare in my school". A small fraction mentioned social media as their preferred information source about science.

We further examined the factors inhibiting effective science communication with female science students. The majority of the discussants mentioned the lack of recognition of the place of communication. One said, "Little attention has been given to communication. Nobody tells the girl child to study science. In fact, from primary school, I've been encouraged to read novels to become a lawyer. I'm studying computer science because of my flair for technology." A little less than the majority said it is cultural stereotypes that bring about poor science culture among females as the major inhibition. A discussant in the engineering department said, I am one of the few females in my class; even the males in my class feel I'm odd there. I've been asked what I was doing in engineering several times."

## 6. DISCUSSION

The finding of this study indicates that the prevailing source of information for female students in STEM education is newspapers supporting the idea that science sections exist in rely on newspapers and magazines where they occupy insignificant space when compared to sports and entertainment (Dutta & Batta,2013). It is important to note that this trend is unfavourable to females who in the course of their daily routines may not always have the time to read newspapers. The reliance on mainstream media in disseminating scientific information to women may not be appropriate because research has shown that the media themselves perpetuate stereotypes.

When it came to the most preferred Channels of communicating science by the respondents, face-to-face communication outnumbered the other forms of communication, suggesting that the prevailing approach of leveraging mass media to communicate science is a deficit. The use of mass media in spreading information has a lot of shortcomings as revealed by the diffusions theory. Interpersonal channels which take cognizance of the demographics/characteristics of the audience and interpersonal interventions are paramount (Buchi, 2008; Rogers, 2013). This finding validly supports Tipaldo's (2013) finding that the potential of the direct methods has not been properly harnessed in science communication in Turin, Italy. More so, this finding that females preferred face-to-face communication has been consistently documented in previous studies (Baltitude, 2011; Shiju, 2017). As noted by Baltitude (2011) outside of its being able to give scientific information entertainingly, it is particularly useful in sustaining preexisting interest in science education. This suggests that the STEM information sources for females need to be re-examined. However, several contrasting studies have shown that social media hold more advantages to science communication than other forms (Collins, Huffman & Rock, 2016). This inconsistency may be because of the differences in gender since the present study focused on female demographics.

Furthermore, the study found that the lack of science communication is the major impediment to closing the gender gap in Nigeria. This is consistent with previous studies, the more people are exposed to scientific information, the more they would find science useful (Odey, 2012; Dutta & Batta, 2013) Dutta and Datta (2013, p.17) explained that "a knowledgeable crop of science journalists, a surfeit of the media communication, communication savvy scientists and a vibrant public interest in science are the conditions needed for communication to blossom." It suffices to bear in mind that in as much as communication is a key ingredient for promoting science education among females, the sources of information matter when it comes to engendering attitude for science education among females as demonstrated by our second finding earlier discussed above

## 7. LIMITATIONS

This study had some limitations. First, the study should have used triangulation; a combination of methods. Further studies may enrich the findings of this study by employing both qualitative and quantitative methods to provide conclusive evidence.

Second, although this study found that face-to-face communication (direct channel) is the most preferred information type by females, a portion, though insignificant, also indicated their preference for social media. This could be because of females' dominance on social media as documented elsewhere in Osuagwu (2015). Further studies would need to be carried out to show the benefit of social media to women in STEM.

Finally, this study did not consider age as a demographic variable that can influence media preference. Females in STEM may have different communication preferences depending on their ages. The young females may have their preferences differing from the adults as demonstrated by Tipaldo's (2018) research. It is hoped that future research will investigate what communication arsenals can benefit what age more.

## 8. CONCLUSION

Irrespective of its limitations, the present study has some theoretical and practical implications. For its theoretical relevance, it applies the diffusion of innovations theory to an unrecognized study of the role of communication in bridging the gender gap in STEM education in Nigeria and the theory can be said to be suitable. This study has also extended the scope and geographical boundaries of research as previous studies were not specific about women and were not done in Nigeria.

As for practical relevance, this study has shown the imperative of science education in reducing the gender gap in STEM education in Nigeria. It has shown that communication has to be tailored to suit their preferences. Despite the proliferation of digital technology, there is a need to package STEM information entertainingly, and that can only be done through face-to-face- interaction. The mainstream media are still widely in use for science communication, they are not suitable for improving science literacy among women. Face-to-face activities could help improve women's knowledge, make well-informed decisions regarding STEM and make them role models to future female scientists.

Also, the findings have practical relevance for the education field and general stakeholders who often think of different communication channels for reaching out to students and the public. The study’s findings, which hold a strong implication for education, stress the significance of personalised (face-to-face) communication as a principal agenda setter for science communication to females.

## 9. RECOMMENDATIONS

The government should fund the training of journalists in science education in addition to funding specialized newspapers and magazines to cater to women in science. This may help stimulate their interest in seeking scientific information in the mainstream media.

Second, scientific activities should be put in place, to make science communication a routine, not a happenstance, Such activities include science busking (a form of science street performances, where science is used to draw in a crowd and explain a topic to them), sci-art exhibitions, Science

Cafés and science festivals, should be encouraged by professional bodies like Academy of Sciences for the Developing World (TWAS), the Women in Global Science and Technology (WIGSAT), the Nigerian Association of Women Scientists (NAWS), the Nigerian Association of Women in Science, Technology and Mathematics (NAWSTM), Gender Studies Association of Nigeria (GSAN) among others. All those will help in creating direct avenues for scientific exchanges.

Lastly, the government should recognise the place of communication especially face-to-face communication in bridging the gender gap by ensuring that it is given its pride of place in its science and technology policy when being revised. Also, multichannel communication should be employed where two or more approaches are employed to create a synergy that would make science communication effective. For instance, the new media could be used in promoting science museums and events for women. In sum, an enlightenment campaign to encourage parents to allow their female children to study science should be put in place.

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