Coverage and Framing of Emerging STI and STEM by Four Major Nigerian Newspapers and Implications for National Development

Herbert E. Batta
Nnamdi T. Ekeanyanwu
Charles D. Obot
Iniobong C. Nda
Department of Communication Arts
University of Uyo, Uyo, Nigeria

Doi: 10.19044/esipreprint.9.2022.p308

Approved: 18 September 2022
Posted: 20 September 2022

Cite As:
Batta H.E., Ekeanyanwu N.T., Obot C.D. & Nda I.C.(2022). *Coverage and Framing of Emerging STI and STEM by Four Major Nigerian Newspapers and Implications for National Development.* ESI Preprints. https://doi.org/10.19044/esipreprint.9.2022.p308

Abstract

In Nigeria, there is a gross deficit of empirical research on emerging STI content in the media. This study investigated four prominent newspapers in Nigeria to ascertain the extent to which STEM and emerging STI are covered and framed. We posed the following research questions covering reportage, sourcing, framing, and implications. The methodology involved a content/framing analyses of *Daily Trust, Leadership, The Guardian* and *The Punch.* A census sampling of 728 newspaper issues was conducted covering a period of six months spanning between December 1, 2020 and May 31, 2021. The results indicate a near zero coverage of emerging STI in the four dailies. Other results show that of the eight areas of STEM examined, medical/health sciences (48%), agricultural sciences (24%) and ICTs/engineering (19%) received more coverage. Earth/environmental sciences, physical and chemical sciences, marine, space, and mathematical sciences were accorded near zero coverage. On sourcing of STEM stories in the four dailies, 54% was sourced in-house by the journalists, 33% came

from national STI institutions, while 13% was obtained from foreign and internet sources. On framing, 42% of STEM stories were framed in terms of health, risk, and safety; 39% in economic and political frame, while academic, environmental, ethical and "other frames scored between 7% and below. The conclusion of the study is that newspaper coverage of emerging STI was near zero reflecting and projecting the dismal status of emerging STI in Nigeria while the coverage and framing of STEM depicted the media agenda of concentration on medical, agricultural, and ICT endeavours to the neglect of others.

Keywords: Techno-science, Print Media, Content Analysis, Developing Country

Introduction

The importance, relevance, and significance of science, technology and innovation (STI) including the emerging ones are generally acknowledged in most societies. Progress, development, and advancement in most countries be that in social, cultural, economic, or political realms often depend on STI. Nigeria is not left out in the quest for harnessing STI for development purposes. It formulated a Science and Technology (S&T) policy first in 1986. Since then, three revisions have been undertaken in 1997, 2003, and 2012 (Oyewala, Adebowale and Siyanbala (2017).

The extent to which the Nigerian mass media particularly newspapers (with their capacity to confer status on important national issues and set agenda for public, social, and political discourses) have reflected STI activities in their coverage and framing is the focus of this investigation. The rationale here is that the media including newspapers are also one of the catalysts of national development. They are pivotal to the creation of awareness, provision of knowledge/education, advocacy for public policy formulation and implementation as well as sensitisation and mobilisation for social action.

Scholars agree (Mashi, Inkani and Yaro, 2014) that the evolvement of S&T policy in Nigeria was in recognition of its crucial role as instruments for national development. Nigeria recently outlined an STI Roadmap beyond the 2012 STI policy for 2030. However, Nigeria's commitment deserves investigation. Newspaper coverage and framing can help gauge these commitments because Mailafia (2017) laments that a dismal 20% of Nigerians are admitted to study Science, Technology, Engineering and Mathematics (STEM) in tertiary institutions. Besides, Edward-Ekpu (2017) informs of the dearth of working science and technology museums in Nigeria. Likewise, Braimoh (2015) regrets the absence of science and technology parks. Apart from numerous science/technology agencies

departments, offices, institutes, polytechnics, and universities which Nigeria boasts of; these are avenues for public education and popularisation of STI.

As experienced in many parts of the developed world, STIs and emerging STIs have contributed to the resolution of health problems and disease burdens. They also provide solutions to food insecurity and water/sanitation challenges. Likewise, environmental problems, illiteracy and other educational deficits, and human security challenges are often confronted with STI solutions. These are made possible by research and advancements in the sciences, technology, innovation and emerging disciplines in artificial intelligence/robotics, nano-science/nanotechnology, genomics, nutrigenomics, gastrophysics, proteotronics, etc.

The extent to which these STI issues are reported and framed in the media are reflective of the extent to which the STI activities occur in a given nation. It follows therefore that, if STIs contribute significantly or otherwise to national development, this would equally be depicted in the media.

Statement of the Problem

The impact of science, technology and innovation on society is not in doubt. This realisation must have accounted for Nigeria's establishment of a Federal Ministry of Science, Technology and Innovation and subsequent formulation of a National Policy on Science, Technology and Innovation in 2011.

The world over, science, technology and innovation have phenomenally altered the course of the history: millions have been lifted out of poverty through advancements in agriculture; developments in information and communication technology have shrunken much of the world bringing together far-flung peoples of the world and revolutionising education and workplaces as well as improving intelligence gathering and securing lives and property. Expansion of knowledge in biotechnology, genomics, nutrigenomics, gastrophysics has fundamentally improved health, prevented diseases and solved chronic maladies. Similar societal progress, scholars have documented; has been witnessed in the use of artificial intelligence, robotics, nanoscience, nano technology and other emerging STIs in manufacturing, industrialisation, medicine and environmental preservation (Batta, Ashong, and Obot, 2014; Sales, Perigrini, and Goersch, 2014; Banerjee, Pal, and Ray, 2015; Keener, Hoban and Balarubramanian, 2015; May, 2015; Perez, Deligianai, Ravi, and Yang, 2018; Joshi, 2019).The extent to which these are true for Nigeria has not been empirically established in the field of communication research. Communication scholars cannot readily say the extent to which Nigeria's Science, Technology and Innovation policy has been communicated in the public sphere or the extent

to which science, technology and innovation's impact on Nigeria's development has been communicated.

One of the ways to gauge the communication of STI in a country is to look at its press such as the newspapers. To demonstrate this, *Leadership* newspaper on March 24, 2021 stated, "recovery and going back to sustainable economic growth … must be hinged on sound science and engineering infrastructure, well-trained and skilled operators, and a leadership that provides the necessary vision…" (p.20). The same newspaper on December 9, 2020 quoted the Nigeria's space agency as stating that, "space science and technologies have the potency of revealing the variety of ways to improve public administration, democratic processes, public sources, and accountability" (p.28). Likewise, *The Guardian* of May 3, 2021 quoted a Nigerian minister as remarking thus: "low and inappropriate application of STI in agriculture in Nigeria is responsible for the inability of the nation's agricultural products to compete globally" (p.42). The same paper also captured the National Office for Technology Acquisition and Promotion on December 17, 2020 commenting that, "innovations, inventions, and researches are key drivers to Nigeria's economic prosperity" (p. 30).

Apparently, Nigeria seems to be struggling with the implementation of its Science, Technology and Innovation policy whereas the world has moved beyond basic STIs to emerging STIs which are more advancedand much more impactful. To what extent then are Nigerian newspapers reporting and framing these emerging STIs in addition to the basic ones? To what extent is this coverage reflective of emerging STI activities in Nigeria? What does such coverage portend for Nigeria's national development?

Research Questions

This study was guided by the under listed research questions:

i) in what form or content genre do *Daily Trust, Leadership, The Guardian,* and *Punch* newspapers disseminate STI content?
ii) to what extent is depth accorded STI matters by the four selected newspapers?
iii) from what information sources do the newspapers base their reportage/coverage of STI stories?
iv) to what extent do the selected newspaper reflect the wide breadth of perspectives in their framing of STI issues?
v) what are the implications of the findings on Nigeria's national development?

Emerging Science and Technology

Researchers have offered useful insights into emerging scientific fields in recent times. Dvorsky (2013) identified eleven (11) emerging scientific fields that everyone should know about. Likewise, Hudson (2014) reviewed top ten emerging technologies that are transforming the world. Similarly, Nwazor (2017) detailed five emerging technologies in science that will shape human lives in years to come. Let's examine some of these emerging sciences and technologies.

Neuro-parasitology is an emerging field devoted to the study of how parasites alter the behaviour of their hosts as part of their reproductive strategy. Reproduction occurs when the parasite is consumed and excreted by a third party. An example is given of the hair worm that releases an admixture of chemicals that causethe grasshoppers that host them to commit suicide by jumping into water. This allows the hairworms to swim out of their drowned hosts (Dvorsky, 2013). Studies such as these permit scientists to understand how parasites affect the nervous system and behaviour of hosts so as to find solutions to abnormal behaviours induced by parasites.

Another emerging field is Synthetic Biology. Nwazor (2017) explains that synthetic biology allows scientists to produce biological organisms from nonliving forms with technology. Examples are producing a computer prototype of a bacterium or the creation of a synthetic cell. Dvorsky (2013) states that, synthetic biology is the design and construction of biological parts, devices, and systems. It involves manufacturing for example the complete genome (gene structure) of a bacterium, by putting together its chemical constituents. It also involves the creation of a digital DNA and printing and then introducing it into a living microorganism.Synthetic biology has led scientists to the idea of *in vitro* meat i.e. beef produced not from cattle but grown in the laboratory. Hudson (2014) explains that it involves recreating in the lab, atoms similar to those that compose the meat and it would not be different in many ways – taste, texture, or otherwise.

Nutrigenomics**,** yet another emerging science combines studies in nutrition and genes. Dvorsky (2013), states that, the emerging field is equally known as nutritional genomics and is an investigation of the intricate relationship between food and genetic expression. Scientists in this new field probe the function of genetic variation, dietary response, and how nutrients impinge upon human genes. What we eat therefore influences how our genes are structured, and the structure of genes regulates what we eat. Nwazor (2017) adds that in the near future, nutrigenomics specialists could tell the exact/best diet based on one's DNA and recommend specific meals capable of altering one's genetic configuration.

Gastrophysics merges gastronomy and physics combining interests in physical, chemical, nutritional, psychological, and cognitive sciences

alongside professional practitioners, such as chefs, and gastronomical entrepreneurs/innovators (Mouritsen and Risbo, 2013). Molecular gastronomy depends largely on thoroughly grounded sciences e.g. food chemistry, general food science, and food processing technology: "gastrophysics aims to exploit, on all relevant time-and length-scales, recent advances in the physical sciences to advance the scientific study of food, the raw material, the effects of processing food, and quantitative aspects of the physical basis for food quality, flavour, appreciation, and absorption in the human body" (p.2). To van der Linden (2013) it provides the rationale for the integration of gastronomy as the act of enjoyable eating and drinking achieved by stimulating different senses at different rates and levels. Physics, "helps one to understand how macroscopic, physical food properties relate to molecular properties and interactions of the ingredients as a function of the parameters of ingredient concentration, ingredient type, energy input, temperature and time" (p.1). Therefore, integrating physics with gastronomy yields efficient innovation.

Next, Proteotronics reflects the interest electronic engineers are showing in understanding the function, structure, and operational networking of proteins. The Physics arXiv Blog (2014) states that proteotronics involves the ability to model and predict the electronic behaviour of proteins and also come with the ability to deploy it as a dependable constituent in more intricate systems e.g. electronic circuits found in LEDs, transistors, etc. Also known as organic electronics, Nwazor (2017) simplifies it thus, "while some branches of science focus on making machines act more like living creatures, organic electronics focuses on making organic elements behave more like machines" (p.1). This field is drastically changing the design and integration of prosthetics and other medical devices. Dvorsky (2013) notes that it uses conductive polymers and conductive small molecules to design, synthesise, and process workable living and non-living materials using advanced micro- and nano fabrication techniques and circuit designs.

Also, epigenomics is the study of inheritable changes beyond those in the DNA sequence and involves two main modifications of DNA or chromatin – the kernel of genes (Callinan and Feinberg (2006). It merges the sciences of epigenetics and genomics with the objective of appreciating gene regulation and the value it adds to the growth of cells and their variations as well as disease and aging. Hudson (2014) explains that humans suffer from various forms of diseases as a result of defective genes but genome editing encompasses the science and technology that replaces those malformed genes. This raises the possibility of eliminating genetic maladies.

Agricultural Drones: with the population of Nigeria increasing exponentially plus climate change affecting agriculture; feeding the large population poses a challenge. However, drones hold some promise for

solving food insecurity. They are unmanned flying devices using cameras, processors, global positioning system (GPS) units that help capture intensive and extensive photographs of agricultural lands. These images which are later analysed help farmers to identify crops lands that require more attention or other areas with irrigation or pest problems which are quickly taken care of before greater damage and crop losses are incurred (Hudson, 2014).Drones have been used lately in journalism to gather information about news events such as wars, riots, demonstrations, traffic, etc. where it is impossible or unsafe to send human reporters. In agriculture, drones help reduce use of farming resources and boost crop production.

High Speed Transportation: Nigeria is a large country of heavily populated regions. Yet the system of transportation is archaic, slow, expensive, unreliable, dangerous and incapable of supporting social development and economic growth. Nigeria would have developed more sustainably if it had a more efficient means of transportation – to move raw materials, manufactured goods, industrial machines, agricultural produce, people and services around the several regions. Scientists and technologists are currently working on creating super-fast transportation at least at the theoretical level that can shorten a six-hour journey to 35 minutes traveling at the maximum speed of 760 miles per hour. Hudson (2014) states that such a system would be overly expensive costing between six and eight billion US dollars but that in a globalised world, people need to move around quicker than air trips can afford us at the moment.

Another emerging field, Robotics and Artificial Intelligence systems have made tremendous progress. Wilkinson, Bultitude and Dawson (undated) have commented that robotics, genetic engineering and nanotechnology have been identified as the three most significant emerging technologies of the 21st Century. Hudson (2014) writes about powered exoskeletons which are being conceived to help paraplegics to stand, walk and making room for more movements and a more humane lifestyle.

Other emerging sciences and technologies include quantum biology, exo-meteorology, cliodynamics, recombinant mimetics, computational social science, cognitive economics and quantitative biology (Dvorsky, 2013). There are also redox signaling technology and neuro-morphic engineering (Nwazor, 2017) for interested persons to read about.

Media Coverage, Framing of Emerging STI, and the Public

The mass media help to popularise science and technology, aid the public understanding and learning of science and thereby contribute to the capacity of citizens to participate knowledgably in public discourse and policy formulation. This participation is key to an involvement and

engagement in informal decision making critical in a science-driven and technology-propelled democracy.

In the Chinese neurosurgical journal, Acosta, Tran, Okonkwo, Larose, and Bolongan (2017) examined media coverage and public awareness on bioethics and perception of emerging biomedical therapies. Acosta *et al.* observe that the media exert a great influence on public opinion and cell-based treatments. Such influences pertain to, "an exploited absence of successful communication between the public and scientific community, and immediate reactive resolutions by policy makers to gain popularity…. Developing technologies are most stifled when the public is fearful of the new scientific breakthrough or sets unrealistic goals that give false hope" (p.2).To Acosta *et al.* stem cell-based therapies are not adequately represented because of social, legal and ethical considerations. To sort through this quandary, it is important to regard and integrate public opinion and policy making. It is also necessary to ascertain the general good of research among sundry view points; and it is pertinent to decide if integrating education and ethical public opinion can bring about general benefit.

Apart from news coverage, the media often frame subject matters including emerging science and technology i.e. they couch issues in a certain way to convey information, persuade, or influence media message consumers. This influence is critical in the formation of personal, then public opinion. It also affects perception and attitudes. In an article on the evolution of synthetic biology, Torgersen and Schmidt (2013) refer to risk for human health and environment regarding green biotechnology as the dominant frame though there are other frames such as ethics frame, and economic frame which prevail in the stem cell debate. Regarding nanotechnology, an economic frame of technology in progress looms over a risk frame whereas information technology is framed as personally beneficial except the risk associated with cyber security stemming from intentional misuse.

Following from the argument that there is a direct link between media coverage and framing and public understanding of science and technology, Pauwels (2013) who examined public understanding of synthetic biology concludes that, members of the public show enthusiasm for synthetic biology applications when those applications are developed to address societal, medical and sustainability needs, whereas engineering biology is seen as a potential concern if this research is done without investigations of its potential risks and long-term implications.

Indeed, not only is it crucial to know how the public perceives emerging STI but how scientists understand public engagement in emerging science. Braun, Starkbaum and Dabrock (2015) discovered that scientists perceive the public as harbouring a basically risk-centred opinion of science. To address this, various methods of science communication are seen as

having the potential to make science better accepted by the public. On the flip side, public engagement in science through scientist/public interface is regarded as an obligation. Therefore, a provision of better opportunities and organisation perks that consistently and regularly allow scientists to engage with the public i.e. citizens, is desired.

Again, stemming from the notion that media coverage and framing also have influence on public attitudes, Sutcliffe (Undated) states:

> Analysis of 14 of the public dialogues which have been conducted in Europe from around 2005 – 2011 (in areas such as nanotech, stem cells, and synthetic biology showed the public are … interested and excited about how these techniques are being used. They have concerns about safety to people and environment, about how the technology is being used and desires that it be deployed not just for company profit, but for social benefit … much the same concerns that scientists, policy makers, civil society groups and business … often have (p.1).

The same cannot be said about the attitude of the press to emerging science in Nigeria because one is uncertain about the depth of emerging science and technology or the prevalence of knowledge and research about emerging science and technology in the country.

Theoretically, the coverage and framing of science, technology and innovation in the printed media can be explained. The agenda setting theory gives vent to what newspapers do to bring cogent issues to the front burner by making them gain public salience. Similarly, the framing theory provides grounding for appreciating the ways in which newspapers couch their reports in variegated perspectives. This permits news consumers to apprehend STI reports in specific directions.

The agenda building hypothesis allows the government, the media, and the public to impact one another as far as public policies are concerned. It gives a better conceptualisation of this process than the agenda setting theory conceived by Cohen (1963) to reflect the ability of the media to effect the direction in which consumers view media reports. Through ideas expressed by researchers (Baran and Davis, 2009) agenda building/agenda setting theory help explain how the media focus attention on the ways in which readers interface with STI information. The theory illustrates the connection involving media exposure to STI information, the willingness of the readers to find information on STI, and how the readers perceive STI matters.

Closely related to the agenda-setting theory, the framing theory as Entman (1993, p. 56) defines is meant …"to select some aspects of a perceived reality and make them more salient in communicating text, in such a way as to promote particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described." To apply this theory to STI matters, it explains how newspapers for instance, define and explain STI issues, how they describe personalities/institutions/sources responsible for STI messages and how STI problems are solved. In defining STI issues, newspapers may deliberately select their focus which may influence readers to see them as political, economic, legal, academic, medical or ecological.

At the macro-level, the social construction of Technology theory provides a descriptive approach to understanding the role of human action in determining the shape of technology. Mackensie and Wajcman (1985) explain that the theory adopts the concept of interpretive flexibility to convey that technological artifacts are constructed and interpreted actually in terms of flexible thought, appreciation, and design. It also encapsulates the primacy of social groups, interactions, and meaning exchanges to arrive at consensual decisions on cultural norms, beliefs, and values as affect meanings assigned to technological productions. It is true that as newspapers disseminate STI information they are also expressing the cultural interpretations society gives to science, technology, and innovation. They help to imbue national technological aspirations with social/cultural meanings.

Research Method

This study adopted the content analysis research design to evaluate both qualitatively and quantitatively the extent to which four Nigerian newspapers depicted the dissemination of STI contents. The newspapers involved were daily issues of the *Daily Trust, Leadership, The Guardian*, and *The Punch* from December 1, 2020 to May 31, 2021. The six-month period was reasoned as adequate to extract a definite trend in coverage/reportage of salient public issues. The population of the study amounted to 728 issues of the daily national/regional newspapers. This figure seemed manageable so a census sampling of the population was undertaken.

The contents of the newspapers were analysed on the basis of two broad categories namely: Emerging Science, Technology, and Innovation with clearly defined components to include biotechno- logy/genomics, synthetic biology, nutrigenomics/gastrophysics, proteotronics/neuroparasitology, artificial intelligence/robotics, agricultural drones, jets-peed land transport and nanoscience/nanotechnology. The second category consisted of Science, Technology, Engineering, and

Mathematics (STEM) components sub-categorised and defined into physical/chemical sciences, medical/health sciences, earth/environmental sciences, marine sciences, agricultural (crop/soil/animal) sciences, space sciences, Engineering, ICTs; and mathematics.

The coding parameters for content analysing the STI matters were (a) content genre/form separated into news/features, opinions/editorials, and specific section/pullouts; (b) depth of coverage, delineated into brief, medium, and lengthy; (c) sources of reports pigeon-holed into in-house sources, national STI sources, and foreign/internet sources; (d) framing of STI content designated into economic/political frame, health/safety/risk frame, policy/ethical frame, academic/information frame, environmental/sustainability frame, and "other" frame.

The unit of analysis used in the coding process was the newspaper articles disseminated in the form of news, features, opinion, column, editorial or special section. Analysis was conducted based on tabular renditions and calculation of percentages using the Statistical Package for the Social Sciences.

Rationale for the Choice of newspapers

The Guardian and *Punch* newspapers are national in outlook and both have considerable nation-wide readership. However, while *The Guardian* is more of an elite newspaper, the *Punch* is more populist but both are based in Nigeria's south, the commercial capital-Lagos. On the other hand, the *Daily Trust* and *Leadership* are popular, regional newspapers with strong presence in the Northern part of Nigeria. They are both based in Nigeria's seat of government – Abuja. The four newspapers were selected purposively for reasons of accessibility, wide readership, regional/national spread and the expectation that they cover a wide range of issues including science, technology, and innovation.

Results and Discussion

The discussion of the findings of this study is based on the research questions. The first question asked about the form or content genre in which the coverage of emerging STI occurred in the analysed newspapers.

Coverage of Emerging STI

Table 1

Newspaper Coverage/Framing of Emerging STIs and STEM * Prominence Attached to Newspaper Coverage of Emerging STIs and STEM Crosstabulation

			Prominence Attached to Newspaper Coverage of Emerging STIs and STEM			
			Feature/News	Opinion/ Editorials	Section/ Pullout	Total
Newspaper Coverage/Framing of Emerging STIs and STEM	Daily Trust	Count	250	8	0	258
		% of Total	21.7%	.7%	.0%	22.4%
	Leadership	Count	0	203	60	263
		% of Total	.0%	17.6%	5.2%	22.8%
	Guardian	Count	0	0	354	354
		% of Total	.0%	.0%	30.8%	30.8%
	Punch	Count	0	0	276	276
		% of Total	.0%	.0%	24.0%	24.0%
Total		Count	250	211	690	1151
		% of Total	21.7%	18.3%	59.9%	100.0%

The study shows in Table 1that little or no emerging STI matters featured in the news, opinion, feature, editorial or special sections of the four newspapers. However, the study indicates that other STEM subjects in the four newspapers occurred at the rate of 60% in special sections, 22% as news features, and 18% as editorials/opinions.

These findings illustrate the paucity of reports on emerging STI in the four newspapers and shows a concentration of STI stories in dedicated pages and much less so in news, feature, and editorial/opinion pages. The importance of media coverage of science, technology and innovation including emerging STIs cannot be overemphasised in the modern world particularly in developing countries where there is ample need to use STI for development purposes. Nanowerk (2013) underscores the fact that the media significantly influence the public image of science and technology because press reports boost awareness of covered subjects, bolsters information about topical social discourses. They also highlight technical applications, new opportunities, and risks related to new technologies. In a study conducted in German, Swiss and Austrian print media, Nanowerk (2013) observes that 88% of the reports were captured as news and a much smaller percentage as opinions/features. Focusing on nanotechnology reports, the study showed that a greater percentage of the articles were featured in the science section of the newspapers as this study also shows.

The lessons that can be drawn from these findings are that while it is crucial to feature STI stories in science sections of newspapers, for this gives STI specialists the confidence to participate in science reporting through news, commentaries, interviews and essays; it may restrict the general public

from doing so from the assumption that the sections are too technical and thus reserved for specialists.

There is certainty that the mass media including newspapers influence public attitudes (Boholm and Larsson, 2019) therefore the participation of varied stakeholders – the public, scientists, journalists in the creation and dissemination of STI messages would require STI content to be featured in equally variegated ways as news, features, opinions, editorials, commentaries. This is to take advantage of the heterogeneity of the public and the fact that if not properly handled, media representation does become fragmented and ambiguous. It is equally important to guard against event-specific or incidental coverage of STI. Mazerik and Rejeski (2014)in their study of the communication of synthetic biology observe that numerous news stories were propelled by important announcements and events. What can be deduced from this observation is that where emerging STI information is spread across the newspaper in the various content forms on routine and not on episodic basis, chances are that the subjects would be treated in greater detail, covering benefits, challenges, risks, policy and regulatory issues, etc. This conclusion was apparent in Acosta, Tran, Mair, Okonkwo, Larose and Borlongan's (2017) study of media coverage and public awareness on bioethics perception of emerging biomedical therapies. They stated that the media strongly affected public opinion on cell-based therapies and that there was an underrepresentation of the gains of cell based therapies regarding ethical, legal, and social factors.

Similarly, there is a nexus between media articles and perception of emerging technologies. This carries the notion that the way news stories are handled in the newspapers does influence how emerging technologies are perceived. Shipman (2015) reports that when news articles point to conflict within the scientific fold on a given emerging technology e.g. synthetic life or nanotechnology, the readers who defer to scientific authority on the subject tend to view the technology as a risk.

This finding illustrates the salience of the agenda setting theory to the extent that the media reporting of STI has a direct way of influencing the manner in which the media users perceive the messages. The media audience tends to be exposed to more of what the media cover. They also tend to form opinions about what the media feature but since the public is heterogeneous, has other influences exerting upon it, people need more informed consistent, and knowledge-driven information from the media and other sources to make decisions that are less reliant on values, beliefs, and emotions.

Newspaper Sourcing of STI Information

Table 2

Newspaper Coverage/Framing of Emerging STIs and STEM * Sources of Emerging STIs and STEM Reports in Four Nigerian Newspapers Crosstabulation

			Sources of Emerging STIs and STEM Reports in Four Nigerian Newspapers			
			In-House Sources	National STI/STEM Sources	Foreign/ Internet	Total
Newspaper Coverage/Framing of Emerging STIs and STEM	Daily Trust	Count	258	0	0	258
		% of Total	22.4%	.0%	.0%	22.4%
	Leadership	Count	263	0	0	263
		% of Total	22.8%	.0%	.0%	22.8%
	Guardian	Count	93	261	0	354
		% of Total	8.1%	22.7%	.0%	30.8%
	Punch	Count	0	108	168	276
		% of Total	.0%	9.4%	14.6%	24.0%
Total		Count	614	369	168	1151
		% of Total	53.3%	32.1%	14.6%	100.0%

The next research question was about information sources that the four newspapers based their reports on. The findings show that, for emerging STI, the data for this are not significant at all because that content received near zero coverage. However, for STEM, the data in Table 2 show that the majority of the stories (53%) emanated from in-house sources – the journalists themselves. Also, 32% of the articles were based on national STI institutions and experts whereas 15% of the content was sourced from foreign and online outlets. The import of this finding is that journalists working in the four examined newspapers contributed the majority of the stories on STEM followed by contributions from national STI stakeholders.

In a study about nanotechnology in the media, Nanowerk(2013) made related, similar findings. But in that study, scientists were by far the most frequently cited sources. They were usually consulted for newspaper content on STI to underscore some aspects of the subject or offer a different viewpoint. Journalists also were reported as the next most important sources whereas political actors and civil society groups such as ecology activists or consumer rights groups, played far less subordinate roles. This finding prioritises the need to have a multiplicity of voices and actors that express and contribute to STI information in the press. This is so because, the public is heterogeneous, media representations of STI could be fragmented and so the need to develop targeted audience - specific communication becomes a necessity (Boholm and Larsson, 2019).

The result of this study also highlights the increasing relevance of the online media as sources of STI information. Though the Internet sources contributed 10% as seen in this study, the Internet as Cacciatore *et al* (2012) note, "is a communication space where multiple actors can contribute ideas and opinions" because, "the Internet increasingly allows diverse citizens to participate in interactive communication in order to realise the interactive and pluralised aspects of public spheres" (p. 4).

This study has also indicated the reliance on STI institutional and expert sources for STI articles. This finding aligns with Ancillotti and Erikson's (2016) conclusion that the press in Sweden and Italy markedly depended on common sources for articles. Also, Ancillotti, Holmberg, Lindfelt and Erikson (2015) affirmed that marked dependence was on scientists and stakeholders who influence media agenda.Therefore, this work has shown the instrumentality of the agenda building hypothesis and the agenda setting theory in the coverage and framing of STI. The study illustrates the roles played by journalists, STI experts, STI institutions and other stakeholders in setting media agenda with implications for public and policy agenda.

Depth of STI Coverage

Table 3

Newspaper Coverage/Framing of Emerging STIs and STEM * Depth of Coverage of Emerging STIs and STEM in Four Nigerian Newspapers Crosstabulation

			Depth of Coverage of Emerging STIs and STEM in Four Nigerian Newspapers			
			Brief Length	Medium Length	Lenghty	Total
Newspaper Coverage/Framing of Emerging STIs and STEM	Daily Trust	Count	92	166	0	258
		% of Total	8.0%	14.4%	.0%	22.4%
	Leadership	Count	0	202	61	263
		% of Total	.0%	17.5%	5.3%	22.8%
	Guardian	Count	0	0	354	354
		% of Total	.0%	.0%	30.8%	30.8%
	Punch	Count	0	0	276	276
		% of Total	.0%	.0%	24.0%	24.0%
Total		Count	92	368	691	1151
		% of Total	8.0%	32.0%	60.0%	100.0%

The result of this study shows that emerging STI did not receive any meaningful coverage so, the question of depth does not arise. Only a pittance of 0.5% of 1151 STI stories dealt with emerging STI. Table 3 shows that out of the remaining STEM stories, 60% of the articles were adjudged long and deep, 32% were of medium length, while eight percent were of brief length.

A full page or more of STI articles were considered long and deep, a half page was seen as medium, while a quarter page or less was taken as brief.

Depth should not only be seen in the context of length. It should equally be seen in relation to the breadth of STI subjects covered. Russell (2010) affirms this position where she states that less space is accorded science matters in traditional media outlets especially in smaller newspapers where content has been slashed in scope and in numbers. She also concluded that extant STI coverage leans in favour consumer-driven health and medicine as this study has also shown.

This lopsidedness in coverage leaves the public in deficit of knowledge or awareness of other aspects of STI that may touch them as humans. Batta, Ashong and Obot (2014) reached a similar conclusion when they observed a near absence of nanoscience/nanotechnology, content in selected Nigerian newspapers whereas medicine/health, ICT and biotechnology were accorded more significant coverage. Similarly, Batta, Ekanem, and Udousoro (2014) found that biomedicine received better coverage than space science, nanotechnology, and geological sciences. Skewed coverage of media subjects such as STI has implications for the agenda setting theory. Since newspapers and the media have the capacity to set agenda or prime media content, it means that the subjects they neglect would lack salience in the public. Media focus on emerging STI might to a large extent influence public perceptions of STI, attitudes to STI, understanding, and acceptance of STI (Groboljsek and Mali, 2012).

One emerging science that hardly received mention in the examined newspaper was nutrigenomics. Neeha and Kinth (2013) explain that nutrition and genes interact at metabolic and molecular levels and so the emerging science applies genetics, industrial public health, food science and gastronomy to regulate body functions, body weight, and health. The essence of media coverage and framing of this field would be to increase awareness and contribute to curbing nutritional and other non-communicable disorders. These diseases include obesity, cardiovascular diseases, diabetes, cancer, and other chronic disorders (Kaput and Rodriguez, 2014; Adzran, Mustapha, Amin, and Frewer 2020).

Considering therefore how important emerging STIs are, the media ought to find ways of gaining knowledge about them, disseminating the same knowledge in ways that are understood by the public, and making sure to lay bare the implications of the emerging STI to human and national development.

Framing of Science, Technology and Innovation

Newspaper Coverage/Framing of Emerging STIs and STEM * Framing of Emerging STIs and STEM Content in the Four Nigerian Newspapers Crosstabulation

			Framing of Emerging STIs and STEM Content in the Four Nigerian Newspapers						
			Economic and Political Frame	Health Risk/Safety Frame	Ethical/Policy Legal Frame	Information/ Academic Frame	Sustainability/ Environmental Frame	Other Frame	Total
Newspaper Coverage/Framing of Emerging STIs and STEM	Daily Trust	Count	258	0	0	0	0	0	258
		% of Total	22.4%	.0%	.0%	.0%	.0%	.0%	22.4%
	Leadership	Count	196	67	0	0	0	0	263
		% of Total	17.0%	5.8%	.0%	.0%	.0%	.0%	22.8%
	Guardian	Count	0	354	0	0	0	0	354
		% of Total	.0%	30.8%	.0%	.0%	.0%	.0%	30.8%
	Punch	Count	0	61	28	77	10	100	276
		% of Total	.0%	5.3%	2.4%	6.7%	.9%	8.7%	24.0%
Total		Count	454	482	28	77	10	100	1151
		% of Total	39.4%	41.9%	2.4%	6.7%	.9%	8.7%	100.0%

Table 4

Another research question asked about the extent to which the examined newspapers reflected the wide breadth of perspectives in the framing of emerging STI issues. The findings of this study show that emerging STIs were not framed in any significant degree because the subject received little or no coverage in the four newspapers. However, for STEM subjects Table 4 indicates that the physical/chemical sciences, medical/health sciences, environmental sciences, marine sciences, agricultural sciences, space sciences, engineering/ICTs and mathematics, the used frames were health/safety and risk frame (42%), economic/political frame (39%), academic/information frame (7%), sustainability/environmental frame (1%), "other frame (9%) and ethical/policy frame (2%). This result indicates the greater use of health/safety/risk frame and the economic/political framing and the dismal application of ethical/policy, academic, environmental, and other frames.

Framing is a significant aspect of media coverage. It depicts the direction accorded subjects. Media news are known to be influenced by the ways in which subjects or topics are depicted by the media. Porcae and Pereto (2018) agree that there is a bidirectional link between the science and technology research community and the media. Writing on synthetic biology, they affirm that both scientists and journalists provide powerful feedback to one another as they collectively shape the ambitions, dreams and realities of synthetic biology. This finding aligns with Anccallotti, Rerimassie, Seitz and Steurer's (2016) analysis of how the media portray synthetic biology in 13 European countries and the USA. They found out that the media are mainly positive in their portrayal, slanted in their depiction of potential benefits (which they emphasise) and risks which they minimise.

In a similar vein, Ancilloti and Eriksson (2016) who probed the media portrayal of synthetic biology in the Swedish and Italian press found

out that the language was comprehensively adequate, the tone optimistic and positive especially with regard to benefits and risks. Also, the portrayal stemmed from common sources of information and a lack of close scrutiny by the media. Ancillotti, Holmberg, Lindfelt and Eriksson (2015) also corroborate these findings.

Reporting on another emerging STI, Epigenomics; Dyke, Ennis, Joly, Walter, Siebert and Pastinen (2020) agree that scientists and journalists tended to exaggerate epigenetic research results and recurring themes in media reportage such as underlining collective responsibilities and immediate personal effects. They warn that this trend if not curtailed, could instigate public concern and thus adversely affecting public understanding of epigenetics, long term risk of epigenetics, and possibly hampering applied healthcare of the field and causing the formulation of flawed policy. Indeed, Lappe's (2016) study emphasises the urgency of monitoring the media reportage of genomic research in order to shape public appreciation and estimation of epigenetics. However, Dubois, Louvel, LeGoff, Guaspare, and Allard (2019) call for an interdisciplinary approach to the social dissemination of epigenetics to enrich our understanding of fresh issues and concerns not envisaged decades earlier.

The media, to Cacciatorre, Anderson, Choi, Brossard, Scheufele, Liang, Ludwig and Xenos(2012) are avenues for the pubic to have a perspective on emerging scientific matters. On nanotechnology, they categorised themes of media coverage into societal implications, policy, and applications. Societal implications were sub-categorised into risk, benefit, and uncertainty. Policy themes were sub-classified into research, regulation, and economy/business. And, application themes were sub-grouped into health, environment, and national security. They found out that online users encountered more themes on environment concerning nanotechnology than American hardcopy newspaper readers.

This current study rather shows that the Nigerian newspapers were more given to health, safety and risk, as well as political/economic themes. However, while Cacciatore *et al*, study was on an emerging STI,the import of this finding is that media framing of emerging STI or STEM requires a broad range of perspectives/approaches for as Powels (2013) states: "the framing process of emerging technologies will require a range of interdisciplinary methods that are perceptive of cultural values and the context of applications" (p. 88). Torgarsen and Schmidt (2013) add that, "to debate, a still, quite abstract technology, participants functionally need a frame that determines which arguments are legitimate and which are relevant. Often, such frames; are based on previous debates over other novel technologies" (p. 44). The media also often reflect the frames used in those social discourses namely risk, economic benefits, personal usefulness,

environmental effects, ethical consideration, etc. as the framing theory of the media suggests.

Implications of Coverage and Framing of STI for National Development

Yet another research question for which answers are sought in this study relates to the implications of newspaper coverage and framing of (emerging) STI on national development. No doubting fact, Nigeria is in dire need of development. Both public and lay texts are replete with evidence that science, technology and innovation including the emerging ones are crucial to the development needs of Nigeria and Africa. To illustrate, *The Unesco Courier* (2012) citing David Dickson then editor and founding director of Scidev.net, stated that, "the biggest single factor determining any country's potentials for achieving sustainable social and economic growth and particularly in the case of developing countries, of attaining … development goals is its ability to access and apply the fruits of modern science and technology in a responsible manner."

To emphasise this point, Ndesaulwa and Kikula (2016) state that, "its role in providing global public goods, science, technology and innovation serve as a crucial driver of rising prosperity and improved national competiveness" (p. 9). Likewise, Wycliffe and Ayuya (2013) see STI as an important, "component of social integration, sustainable development, and poverty eradication based on equity, freedom, justice, governance, peace and prosperity" (p. 470).

There is a problem however. Thatis: to what extent has Nigeria leveraged on the essential nature of STI to develop its people. Is there sufficient STI research and development in the country? Are the coverage and framing of STI indicate that STI is taken seriously in Nigeria?

Table 5

Newspaper Coverage/Framing of Emerging STIs and STEM * COVERAGE OF EMERGING STIs AND STEM IN FOUR NIGERIAN NEWSPAPERS Crosstabulation

			COVERAGE OF EMERGING STIs AND STEM IN FOUR NIGERIAN NEWSPAPERS		
			Emerging STIs	STEM	Total
Newspaper Coverage/Framing of Emerging STIs and STEM	Daily Trust	Count	6	252	258
		% of Total	.5%	21.9%	22.4%
	Leadership	Count	0	263	263
		% of Total	.0%	22.8%	22.8%
	Guardian	Count	0	354	354
		% of Total	.0%	30.8%	30.8%
	Punch	Count	0	276	276
		% of Total	.0%	24.0%	24.0%
Total		Count	6	1145	1151
		% of Total	.5%	99.5%	100.0%

The results of this as Table 5 shows indicate that emerging STI which reflect the latest trend in science, technology and innovation research and development received near zero coverage in the four newspapers examined. If the media are a reflection and projection of societal realities, then it is indicative of the parlous nature of emerging STI in Nigeria.

Newspaper Coverage/Framing of Emerging STIs and STEM * Newspaper Content/Genre of Coverage of STEM Crosstabulation

			Newspaper Content/Genre of Coverage of STEM						
			Physical/ Chemical Science	Medical/ Health Science	Earth/ Environmental Science	Agricultural Science	Space Science	Engineering/ ICTs	Total
Newspaper Coverage/Framing of Emerging STIs and STEM	Daily Trust	Count	2	256	0	0	0	0	258
		% of Total	.2%	22.4%	.0%	.0%	.0%	.0%	22.5%
	Leadership	Count	0	263	0	0	0	0	263
		% of Total	.0%	23.0%	.0%	.0%	.0%	.0%	23.0%
	Guardian	Count	0	29	101	224	0	0	354
		% of Total	.0%	2.5%	8.8%	19.6%	.0%	.0%	30.9%
	Punch	Count	0	0	0	50	10	210	270
		% of Total	.0%	.0%	.0%	4.4%	.9%	18.3%	23.6%
Total		Count	2	548	101	274	10	210	1145
		% of Total	.2%	47.9%	8.8%	23.9%	.9%	18.3%	100.0%

Table 6

Secondly, this study has equally shown in Table 6 that STEM subjects have been fairly reported but then, the concentration is on medical/health sciences, agricultural sciences, engineering/ICTs, and earth/environmental sciences in that order. Physical/chemical sciences,

marine, space and mathematical sciences received but a paltry mention. This lopsided coverage also reflects a less holistic approach to STEM in Nigeria. The STI situation in Nigeria is also symptomatic of the reality in Africa. There are reasons in the literature that explain the dismal status of STI in Africa. Reporting on why Africa must close its science and technology gap, *African Courier* (October, 2021) states:

> Only 0.1% of all patent applications are registered in Africa, compared to 65% in Asia and 25% in North America. Africa is also responsible for only 2% of the world's research output and 1% of research spending. Furthermore, Africa has 11 researchers per million people whilst the best performing countries - South Korea and Denmark had between 7000 to 8000 scientists and researchers per million people.… the deficit of investment in science and technology and absence of economic and scientific infrastructure has undermined the process of economic transformation both at the structural and sectoral levels.

The statistics are indeed grim but what it means is that, if investment in STI in Africa including Nigeria is low, it follows that STI research and developments are at low ebb and that has clearly become apparent in the media coverage of STI as shown in this study.

At the continental level, the African Union in June 2014 developed a 10-year Science, Technology and Innovation Strategy for Africa (STISA – 2024) as part of the African Union agenda 2063 purposed to use STI to enable the realisation of Africa's development goals (Atta-Mensah, 2015). STISA-2024 with two years to go, was envisioned to apply STI to the eradication of hunger and achieve food security, prevention and control of diseases, communication to enhance physical and intellectual mobility, protection of the African space, African integration, and wealth creation.

Africa indeed has a lot of work to do. With 15% of the world's population and 5% of the world's gross domestic product, it needs to be more strategic in research and development spending, investment in infrastructure, career development and funding investments in science innovation and technology for Africa's development (Marsh, 2016). The situation in more recent times going by a *Harvard Business Review* article by Chakrovosti and Chaturvedi (2019) has not improved especially in sub-Saharan Africa. Juma (2016) believes that Africa's numerous economic and social difficulties present a most cogent excuse for techno-science research in major areas such as agriculture, health, ecological management and the built environment. He emphasises that, Africa can bypass years of past

technologies by utilising for civil purposes the potency of solar photovoltaic, robotics, synthetic biology, 3D printing, drones, satellites and genomics.

This study has shown in Table 7 below that emerging science, technology and innovation coverage in the four Nigerian newspapers is rare meaning that there might be no meaningful occurrence of the fields in Nigeria to warrant media attention. Yet the literature is surfeit with indices affirming that emerging STIs are necessary to stimulate or induce human, economic and socio-cultural development.

Newspaper Coverage/Framing of Emerging STIs and STEM * Newspaper Content/Genre of Coverage of Emerging STIs Crosstabulation

			Newspaper Content/Genre of Coverage of Emerging STIs			
			Nutrigenomics/ Gastrophysics	Proteotronics/ Neuroparasitology	AI/Robotics	Total
Newspaper Coverage/Framing of Emerging STIs and STEM	Daily Trust	Count	2	2	2	6
		% of Total	33.3%	33.3%	33.3%	100.0%
Total		Count	2	2	2	6
		% of Total	33.3%	33.3%	33.3%	100.0%

Table 8

Synthetic biology for instance if taken seriously in Nigeria can help developments in healthcare as the current disease burden is high. Karoui, Hoyos-Flight and Fletcher (2019) agree that synthetic biology gives medicine the opportunity to create cell lines with the ability to detect a disease and respond therapeutically. It also makes possible cybergenetics that enables the development of experimental tools meant to regulate cellular processes digitally. Also, synthetic biology can help produce responsive and multifunctional materials for enhanced, protective clothing or building materials.

For environmental protection which Nigeria and Africa need urgently because of the degradation of the environment occasioned by oil spills, gas flaring, pollution, etc; Madin, Darling and Hardt (2019) affirm that new technologies with applications in conservation help in probing, mitigating, and solving major environmental problems. Such innovative technologies include drones, high resolution and nanosatellite imagery, 3D mapping and modeling tools, and autonomous underwater vehicles (AUVs).

Also, gastrophysics requires the attention of Nigerian scientists too because of its significance for food security. At the moment, it appears to be in its infancy in Nigeria. Moritsen and Risbo (2013) notes that the field,

"exploits in all relevant time - and length-scales recent advances in the physical sciences to advance the scientific study of food, the raw materials, the effects of processing food, and quantitative aspects of the physical basis for food quality, flavour, appreciation and absorption in the human body" (p. 2). What this sort of science can do for Nigeria's development cannot be overstressed.

Similarly, research and activities in epigenomics has big implications for development related to human health. Dyke, Ennis, Joly, Walter, Siebert and Pastinen (2020) affirm that epigenomics sheds light on the manner in which environmental interactions influence alteration in genetic expression which might in turn make individuals susceptible to diseases such as obesity, cancer, diabetes, asthma, allergies, cardiovascular disease, depression and autism. These are health challenges which are prevalent in Nigeria which would benefit from epigenomic studies. Epigenomics also examines the effect of environmental factors such as care, stress, toxins, diet on gene expression suggesting that there is a nexus between molecular and social environments (Lappe, 2016);Dubios, Laswel, Legoff, Guaspare and Allard (2019).

The relevance of artificial intelligence and robotics for national development is well known and the contribution of the media in this direction can only be salutary. However, as this study has shown, this is an aspect of emerging STI that has received little or no attention in the examined newspapers. It cannot be gainsaid the extent to which AI and robotics can revolutionise development in education, health, environmental management, agriculture and national security in Nigeria. Sun, Zhai, Shan and Chen (2020) agree that in developed countries newspaper coverage of artificial intelligence cover a wide range of topics including regulation, policy, risk, etc. while the subject is framed as sophisticated, potent, and value-laden. Nigeria needs to pay reasonable attention to AI and robotics research, development and funding. The Nigeria media equally need to follow developments in the sector no matter how modest. To neglect the field is tantamount to discountenancing its portents for national development. Wilkinson, Bultitude and Dawson (undated) have singled out robotics, genetic engineering and nanotechnology as the three most potent emerging technologies of the 21st Century.

Conclusion

This study has shown that emerging science, technology and innovation, as important as they are to modern development, have not received meaningful attention in the four Nigerian newspapers examined. If four of Nigeria's elite/popular newspapers have not done so if we go by the agenda setting theory or the fact that the media are projective and reflective

of society, it means Nigeria's activities including research, funding, scholarship, practice and other developments in emerging STI are dismal.

However, conventional Science, Technology, Engineering and Mathematics (STEM) were accorded attention in the four newspapers but concentration was on biomedicine, agriculture and information/communication technology (ICT). This is good in a sense for it would augur well for health, food security and access to information and education. However, not paying sufficient attention to other STEM areas is inimical to development.

Also, the study showed the tendency for science, technology and innovation matters to be framed in the context of health, safety and risk; and political economy and a proclivity towards neglecting education/academic frame, environmental and sustainability frames as well as ethical/legal/policy frames. Doing so denies the public the necessary opportunity to apprehend STEM and emerging STI in their full spectrum of perspectives.

Based on these findings, we conclude that given our understanding of the centrality of media coverage and framing to public attitudes, perceptions, opinions and acceptance of emerging knowledge and technologies, the press in Nigeria needs to step up its coverage and framing of emerging science, technology and innovation.

Recommendations

These recommendations are therefore expedient. The Nigerian press should, having become aware of the paucity of emerging STI content in the newspapers use its media to advocate more funding of emerging STI research and development. Secondly, since the scarcity of emerging STI matters in the examined newspapers may also stem from lack of interface between scientists/technologists/innovators in universities, research institutes and in the industry, and journalists; journalists should do more to use sundry sources of information on emerging STI.

Thirdly, scientists and other emerging STI stakeholders owe the society a duty to inform relevant heterogeneous publics about developments in emerging STI particularly on how these impinge on Nigeria's development and the realisation of sustainable development goals related to health, food security, environmental protection, education, national security, etc.

Fourthly, in sourcing STEM and emerging STI information, the press should broaden the scope of news gathering beyond themselves and science authorities to cover the public, communities affected by STEM/STI, and opponents of STEM/STI ideas.

Fifthly, care should be taken to frame STEM/STI emerging STI information by covering the array of viewpoints – economic, political,

ethical, legal, risk, environmental, academic, health, etc. so that the public, government, other media can structure their opinions, attitudes, perceptions, knowledge and behaviours upon a holistic, perspectival foundation.

Lastly, the press should ensure that STEM and Emerging STI are neither covered nor framed without exploring and examining all important areas in which science, technology and innovation impact on Nigeria's national development. Particular emphasis should be placed on human, plant, and animal health; education, food sufficiency, environmental wellbeing, access to information, and national security.

References:

1. Acosta, S. Tran, T, Mair, J., Okonkwo, O., Larose, B. & Borlongan, C. (2017). Media Coverage and Public Awareness on Bioethnics Perception of Emerging Biomedical Therapies. *Chinese Neurosurgical Journal*, 3(5) 1-5. Doi: 10. 1186/s41016-0062-3.
2. Adzran, M., Mustapha, C., Amin, L. & Frewer, L. (2020). Predictors of Stakeholder Intention to Adopt Nutrigenomics. *Genes and Nutrition* 15(16) 1-15.DOI.101186/3/2263-020-00676-y
3. Agbongiarhoayi, A. (2015). Promoting Renewable Energy Use in Nigeria *Vanguard*. https://www.vanguardngr.cm/googlescholar.
4. Ancillotti, M. & Erikkon, S. (2016). Synthetic Biology in the Press-Media Portrayal in Sweden and Italy in K. Hagen, M. Engelhard, and G. Toepter (Eds.) *Ambivalence of creating Life, Societal and Philosophical Dimensions of Synthetic Biology* (pp. 141-156). Springer International Publishing.
5. Ancillotti, M. Rerimassie, V., Seitz, S. & Steurer, W. (2016). An Update of Public Perceptions of Synthetic Biology: Still Undecided? *Nanoethics*, 10(3)309-325. Doi:10.1007/s/1569-016-0256-3.
6. Ancillotti, M., Holmberg, N. Lindfelt, M. &Eriksson, S. (2015). Uncritical and Unbalanced Coverage of Synthetic Biology in the Nordic Press. *Public Understanding of Science*, 26(2) 235-250. Doi:10.1177/0963662515609834.
7. Anderson, A. A., Brossard, D. & Schefele, D. A. (2016). News Coverage of Controversial Emerging Technologies: Evidence for the Issue Attention Cycle in Print and Online Media. *Journal of Politics and the Life Science*, 31: 1-2.
8. Atta-Mensah, J. (2015). The Role of Science, Technology and Innovation in Africa's Growth (I). United Nations Economic Commission for Africa (UNECA).
9. Banerjee, G., Pal, R. & Ray, A. K. (2015). Applications of Nutrigenomics in Animal Sector: A Review. *Asian Journal of Animal Veterinary Advances*, 10 (9): 489 -499.

10. Baran, S. J. & Davis, D. K. (2009). *Mass Communication Theory: Foundation, Ferment and Future* 5th ed.) California: Wardworh Publishing Company.
11. Batta, H., Ashong, C. & Obot, C. (2014). Science, Nano-science and Nano-Technology Content in Nigeria's Elite and Popular Press: Focus on Framing and Socio-political Involvement. *New Media and Mass Communication,* 31: 9-19.
12. Batta, H., Ekanem, I., & Udousoro, N. (2014). Techno-scientific Temper of three Nigeria Newspapers. *Developing Country Studies,* 4(26): 57-67.
13. Boholm, A. & Larsson, S. (2019). What is the Problem? A Literature Review of Challenges Facing the Communication of Nanotechnology to the Public. *Journal of Nanoparticle Research,* 21(86)1-21. https://doi.org/1001007/s11051-019-4524-3.
14. Braun, M., Starkbaum, J., & Dabrock, P. (2015). Safe and Sound? Scientist's Understanding of Public Engagement in Emerging Biotechnologies. *PLOS* ONE (10(12): e0145033.https://doi. org/10.1371/; journal. Pone.1045033.
15. Cacciatore, M. A., Anderson, A. A., Choi, D, Brossard, D., Scheufele, D. A., Liang, X., Ludwig, P. J., Xenos, M, & Dudo, A. (2012). Coverage of Emerging Technologies: A Comparison between Print and Online Media. *New Media and Society*, 0(0)1-21.
16. Callinan, P. A. & Feinberg, A. P.(2006). The Emerging Science of Epigenomics. *Human Molecular Genetics*, 15(1) R. 95-R101. Doi: 1093/hmg/dd1095.
17. Chakravosti, B., & Chaturvedi, S. (2019). Research: how technology could promote growth in 6 African Countries. *Harvard Business Review*, December 04.
18. Chen, Y. & Sun, S. (2020). Newspaper Coverage of Artificial Intelligence: A Perspective of Emerging Technologies. *Telematics and Informatics*, 53 https://dio.org/10/1016/j.tele.2020.101433.
19. Cohen, B. C. (1963). *The press and foreign policy*. Princeton, NJ: Princeton University Press.
20. Donk, A. Metag, J., Kohring, M. & Marcinkowski, F. (2012). Framing Emerging Technologies, Risk Perceptions of Nanotechnology in the German Press. *Science Communication*, 34(1): 5-29. Doi:10.1177/1075547011417892.
21. Dubios, M., Louvel, S. LeGoff, A., Guaspare, C., & Allard, P. (2019). Epigenetic in the Public Sphere: Interdisciplinary Perspective. *Environmental Epigenetics,* 5(4) dvz 019, https:// doi.org/10. 1093/ eep/ dvz019.

22. Dvorsky, G. (2013). 11 Emerging Scientific Fields that Everyone Should Know About. February 27, Obtained from i09.gizmodo.com.
23. Dyke, S. O. M., Ennis, C. A., Joly, Walter, J., Siebert, R. & Pastinen, T. (2020). Communicating Science: Epigenetic in the Spotlight. *Environmental Epigenetic,* 6(1) dvaa, 015. Retrieved from https://doi.org/10.1093/eep/dvaa015.
24. Edward-Ekpu, U. (2017). There are no Science Museums or Centres in Nigeria and Most of African. SciTech Africa. http://www.Scitechafrica. Accessed September 25, 2018.
25. Entmam, R. M. (1993). Framing: Towards Identification of a Fractured Paradigm. *Journal of Communication,* 43(4)51 -58.
26. Groboljsek, B., & Mali, F. (2012). Daily Newspapers View on Nanotechnology in Slovenia. *Science Communication*, 34(1): 30-56. Doi:10.177/107555470 11427974.
27. Harsh, M., Woodson, T. S., Cozzens S., Wetmore, J. M., Sumouni, O. & Cortes, R. (2018). The Role of Emerging Technologies in Inclusive Innovation: The case of Nanotechnology in South Africa. *Science and Public Policy*, 45(5) 597-607. http://doi.org/10.1093/scipol/sxc079.
28. Hudson, S. (2014). Top 10 Emerging Technologies that are changing the world. September 15. www.makeuseof.com.
29. Joshi, D. (2019). Drone Technology Uses Applications for Commercial, Industrial and Military Drones in 2020 and the Future. www.businessinsider.com/drone-technology-uses-application?IR=T. (Retrieved on 27th January, 2020).
30. Juma, C. (2016). Forget Natural Resource: Its Science and Technology that will Transform Africa. World Economic Forum, August 17, https://www.weforum.org/agenda/2016/08...
31. Kaput, J., & Rodriguez, R. L. (2021). Nutritional genomics: the next frontier in the postgenomic era. *Physiological Genomics,* January 15, 2004. Retrieved from http://doc.org:/10.11152/ physiol genomics. 00107.2003.
32. Karoui, M. E., Hoyos-Flight, M. & Fletcher, L. (2019). Future Trends in Synthetic Biology – A Report. *Frontiers inBioengineering and Biotechnology*, August 7, https://doi.org/10.3389/fbioe. 2019. 00175.
33. Keener, K., Hoban, T. & Balarubramanian, R. (2015). Biotechnology and Applications. Department of Food Science, North Carolina University.
34. Lappe, M. (2016). Epigenetics, Media Coverage, and Parent Responsibilities in the Postgenomic Era. *Curr. Genet. Med. Rep.,* 4(3): 92 – 97.

35. *Leadership* (Wednesday, March 24, 2021). Applying Science, Engineering Infrastructure for Economic Recovery, p. 20.
36. Mackensie, D. & Wajcman, J. (1985). *The Social Shaping of Technology*. Milton Keynes: Open University Press.
37. Mailafia, O. (2017). Science, Engineering and Mathematics, No Arabic please. *Vanguard*, July 18. http:www.vanguardorg.com. October 13.
38. Mardin, E. M. P., Darling, E. S., & Hardt, M. J. (2019). Emerging Technologies and Coral Reef Conservation: Opportunities, Challenges, and Moving Forward. *Frontiers in Marine Science*. 10:https://doi.org/10.3389/fmar's. 2019.00727.
39. Marsh, K. (2016). How Africa can close its Continent-wide Science Funding Gap. *The Conversation*, April 12, 2016.
40. Mashi S. A., Inkani, A. A. & Yaro, A. (2014). An Appraisal of the role of science and Technology in Promoting National Development Efforts in Nigeria. *The International Journal of Engineering and Science*, 3(2): 56-67.
41. May, M. (2015). Technology Feature: Synthetic Biology's Clinical Applications. www.sciencemag.org/features/2015/09/synthetic-biology-s-clinical-applications (Retrieved on 27th January, 2020).
42. Mazerik, J. & Rejeski, D. (2014). A Guide for Communicating, Synthetic Biology. Synthetic Biology Project. The Woodrow Wilson International Centre for scholars.
43. Mede, N. G. (2022). Legacy Media an Inhibitors and Drivers of Public Reservations against Science: Global Survey Evidence on the Link between Media use and Anti-Science Attitudes. *Humanities and Social Science Communication*s, 9 (40). https://idoi.org.1057/s41599-022-01058-y.
44. Meng, F. & Ellis, T. (2020). The Second Decade of Synthetic Biology: 2010-2020. *Nature Communication*, 11(5174).
45. Mouritsen, Q. G. & Risbo, J. (2013). Editorial: Gastrophysics – do we need it? *Flavour*, 2013, 2(3) 1-2. http://www.flavour. journal.com/content/2/1/3.
46. Nanowerk Spotlight (2013). Nanotechnology in the media.https://www.nanowerk. comspotlight/ spotid = 28564.php.
47. Ndesaulwa, A. P. & Kikula, J. (2016). The Impact of Technology and Innovation (Technovation) in Developing Countries: A Review of Empirical Evidence. *Journal of Business and Management Science*, 4(1)7-11. Doi:10.12691/jbms-4-1-2.
48. Neeha, V. S. & Kinth, P. (2013). Nutrigenomics Research: A Review. *Journal of Food Science Technology*, 50(3) 415-428doi:10/007/5/3197-012-0775-z

49. Nwazor, T. (2017). Five Emerging Technologies in Science that will shape our Lives in the Coming Years. December 6. Huffingtonpost.com

50. Orekyeh, E. & Onourah, N. G. (2014). Nigerian Magazines' Coverage of the Boko Haram Insurgency: A Job well done. In: Ndolo, I. S. (Ed.) (2014). *International Journal of Media, Security and Development* (IJMSD), 1(1).
51. Oyewale, A. A., Adebowale, B. A. & Siyanbola (2017). Nigeria STI policy and the dilemma of implementation. *Research Handbook on Innovation Governance for Emerging Economies* (pp.345-374) Edward Elgar Publishing.
52. Pauwells, E. (2013). Public Understanding of synthetic Biology. *Bioscience,* 63(2) 79-89. www.biossciencemag.org.
53. Perez, J. A. Deligianni, F., Ravi, D., & Yang, G. (2018). Artificial Intelligence and Robotics. arXiv.1803.10813.https://doi.org/10.48550/arXiv.1803.10813.
54. Porcar, M. & Pereto, J. (2018). Creating and the Media: Translation and Echoes. *Life Science, Society and Policy,* 14(19).Doi: https;//doi.org/10.1186/s40504-018-0087-9.
55. Righettic, N. & Carradore, M. (2019). *From Robot to Science Robots. Trends, Representation and Facebook Engagement of Robots* – Related News Stories published by Italian Online News Media. *Italian Sociological Review*, 9(3): 431-454.
56. Russell, C. (2010). Chapter 3: Covering Controversial Science: Improving Reporting on Science and Policy. In D. Kennedy & G. Overholser (Eds.). *Science and the Media.* American Academy of Arts and Science. www.amacade.org/publicationservice-and-media/section/5.
57. Sales, N. M. R., Pelegrini, P. B. & Goersch, M. C. (2014). Nutrigenomics: Definition and Advance of this New Science. *Journal of Nutrition and Metabolism,*Hindawi Publishing Corporation. http://dx.doi.org/10.1155/2014/202759.
58. Shipman, M. (2015). How NewsStories CanInfluence Perceptions of Emerging Technologies. Retrieved from https://phys.org/new/2015-08-news-stories-perceptions-emerging-technologies. html on September 13, 2019.
59. Sun, S., Zhai, Y., Shan, B. & Chan, Y. (2020). Newspaper Coverage Artificial Intelligence: A Perspective of Emerging Technologies. *Telematics and Informatics,* 53: 101433.Doi: 10.1016/; tele.2020.101433.

60. Sutcliffe, H. (undated). Public Hysteria About Technology – Where is the Evidence? Obtained from www.matterforall.org.
61. *The African Courier* (October 25, 2021). Why African must close its Science and Technology Gap – Former President of Mauritius. Africa Media Agency (AMA),http://www.theafrican courier .de/ special / business,why-africa-must-close-its-science-and-technology-gap-president-of-mauritius.
62. *The Guardian* (Monday, May 5, 2021). Why Nigeria's Food Products Can't Compete Globally – by Minister, p.42.
63. The Physics Arxiv Blog (2014). The emerging Science of proteotronics. March 19. Arxiv.org/abs/1405.3840.
64. Torgersen, H. & Schmidt, M. (2013). Frame and Comparators: How Might Debate on Synthetic Biology Evolve? *Futures,* April; 48: 44-54. Doi:10/016j: futures, 2013.02.002.
65. Van der Linden, E. (2013). Opinion: Integration of Gastronomy and Physics for Innovation. *Flavour,* 20132(11): 1-3 http://www.flavourjournal. com/content/2/1/11.
66. Wilkinson, C. E., Bultitude, K., & Dawson, E. (undated) Talking Robots: Emerging public Engagement with Emerging Robotic Technologies. Science Communication Unit, Faculty of Life Sciences, University of the West of England, Bristol. https//www.science.uwe.ac.ak/sciencecommunication.
67. Wycliffe, A., & Ayuya, V. C. (2013). Leveraging Science, Technology and Innovation for National Development in the Light of the Emerging Universities of Science and Technology in Kenya. *Mediterranean Journal of Social Science,* 4(2): 457-457. Doi:10.5901/mjss. 2013.v4r2p457.