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COMMUNICATING RESEARCH FINDINGS IN BASIC SCIENCE AND TECHNOLOGY FOR TECHNOLOGICAL DEVELOPMENT

John Olakunle Babayemi

Department of Science Education, Faculty of Education, Akwa Ibom State University, Akwa Ibom State, Nigeria
babayemioluwole@gmail.com

Uduak James Utibe

Department of Science Education, Faculty of Education, Akwa Ibom State University, Akwa Ibom State, Nigeria
uduakutibe@aksu.edu.ng

Abstract

Communicating research findings in science education and in particular, basic science and technology seem to witness some sorts of ‘statistical jargons’ and lots of complexities with respect to the terms, methods and language of communicating the results. For decades, lots of research works in Nigeria and outside Nigeria have been directed towards improving the standard and statuesque of science education for scientific and technological advancement of the nation. The expected impacts of these robust findings on users and the overall outcomes on technological development of the nation are not encouraging. The reasons could be attributed to the difficulty in interpreting the research results and the form the results are communicated to the users. Research results perhaps and sincerely should have been weapons for greater achievements in our science classrooms for scientific and technological developments of the

nation at large. Study of this nature ensures that research findings have an impact on practice and practitioners including researchers, science teachers, professional trainees and non-professional readers for expected outputs. This paper therefore, addressed communicating research findings in basic science and technology implications for professional trainees and non-professional readers and technological development. Finally, recommendations are made.

Keywords

Communication, Communicating Research, Communicating Research Framework Basic Science and Technology, Research, Utilization of Research

1. Introduction

The study of Basic Science and Technology by all students at Basic Education level in Nigeria suggests its relevance in national development. The subject is made compulsory as one of the requirements for obtaining Junior Secondary Certificate (NPE, 2013, P.25). Basic Science and Technology offered at this level is foundational to subsequent scientific and technological knowledge and skills received at higher levels of learning. Hence, the subject forms foundation for various fields in science, technology, engineering and other science related fields.

A lot of researches have been conducted to improve the teaching and learning of Basic Science and Technology in schools for technological advancements of the nation. The overall effects of these robust findings remain low on students' achievement and technological development of the nation at large. This is reflected in students' low academic achievement in both internal and external examinations at both lower and secondary education levels (Okpala, 2010; Federal Ministry of Education, Research Statistics and Planning Section, 2013). This implies that if the starting point of science, technology, engineering and mathematics seems to be very weak, then, a nation like Nigeria will still depend so much on importing technology. If research will really achieve its purpose and have effects on practice, then it should be communicated to the users effectively.

In every day-to-day activity, communication is necessary, even in the market, homes, schools, offices to mention a few. Without an effective communication, the essence of discussion and the active purpose of a dialogue are forfeited. In science and technology today, communication is an important means of passing on information about novel discoveries. This communication can be verbal, non-verbal, written or oral. Therefore, there is need for effective

communication of research findings or results to the research community. The way a particular result is communicated determines how it will be decoded by the receiver. Research is a scholarly attempt to solve an identified or a defined problem over time and for a specific purpose. The target audience could be a set of individuals, system, situation, fundamental issues and events.

In communicating research findings to the users such as professional users in this same field, the terms and language related to the profession are easy to understand by them. This might not be the same for non-professional readers or professional trainees, who have the willingness to know and grab information about what is presented. But, because of complexity in scientific or complex/technical research terms used, they find it difficult to understand and grab the information. As a result of this, they are not interested in knowing what the finding is all about. People decode information differently based on their different orientations received from research products. Communication means different things to different people. According to Sampath, Panneer-Selvam and Santhanam (2007), communication is defined as:

- Sharing of ideas and feelings in a mood of maturity.
- Interaction which encourages give and take
- A two-way process including feedback and interaction.

It can then be said that communication involves sharing ideas, which finally results in feedback and interaction. The feedback from the users with reference to communicating research reports can then be beneficial or not impacting. For effective communication, there must be enhanced channels of passing on information, the message or information and the receiver of the message passed. Therefore, according to Sampath et al. (2007), there are generally four (4) components in the process.

- Sender
- Message
- Medium
- Receiver.

For the purpose of this paper, communication research process involves:

- The researcher-sender
- Findings-message

- Medium-Communication
- Receiver-Research users
- Feedback-Users' Response

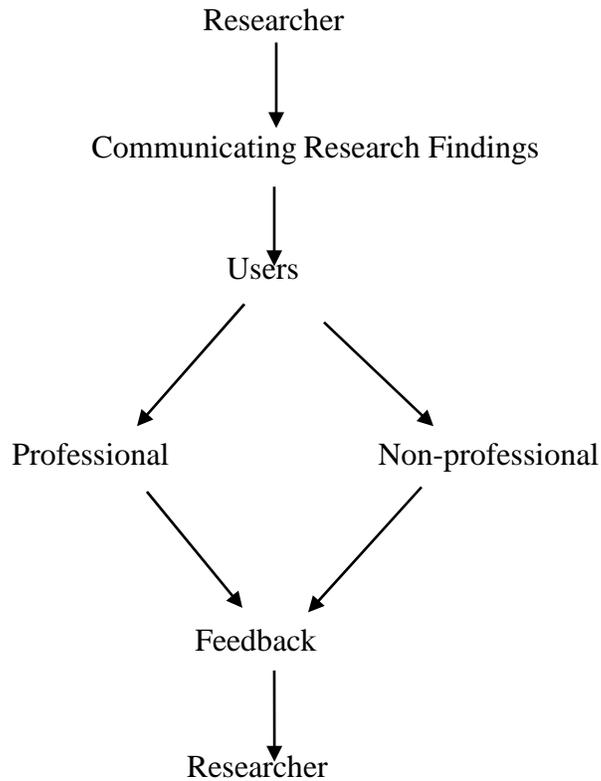


Figure 1: *Communicating Research Framework*

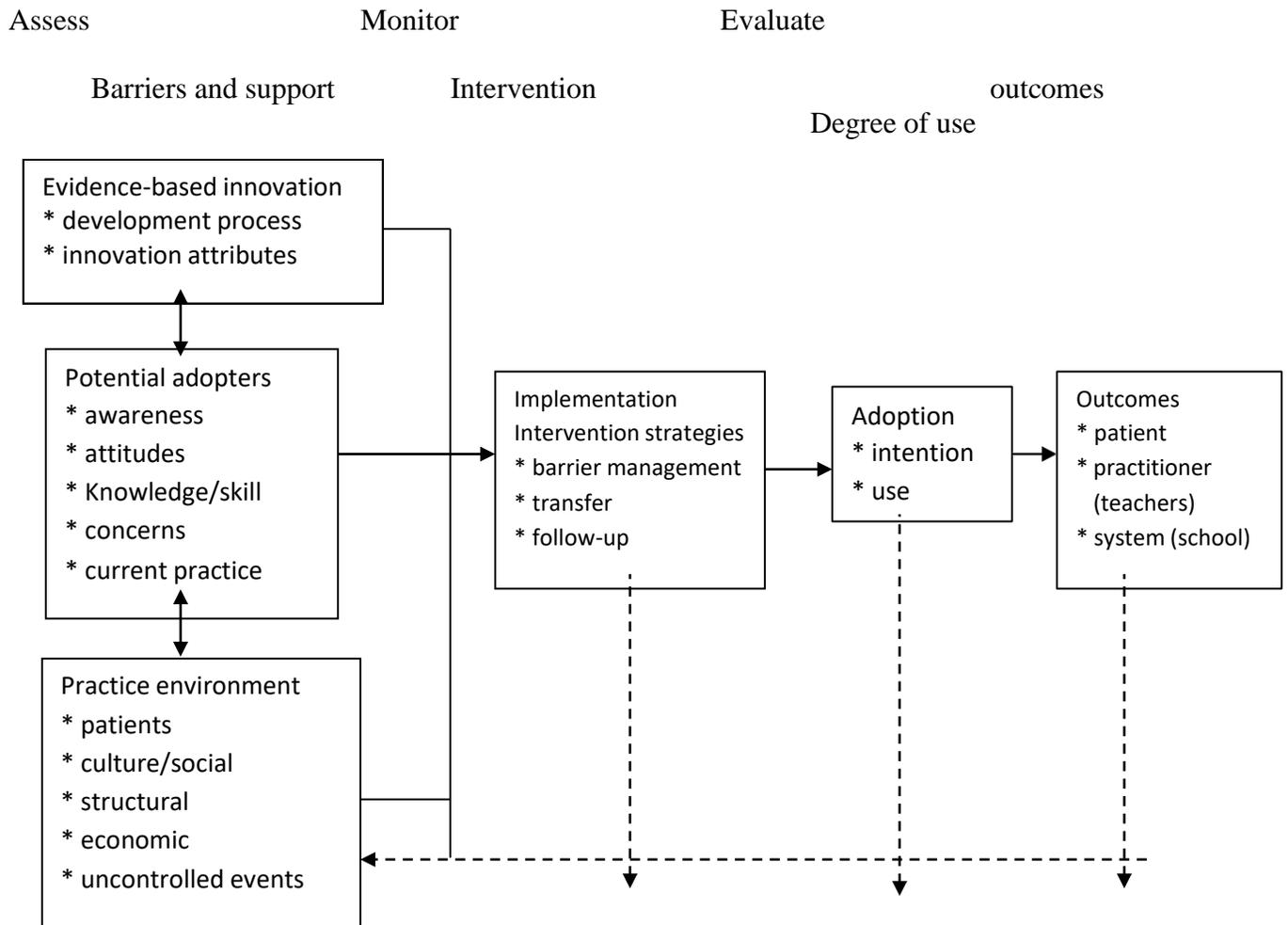
Every information or idea passes through a source (researcher) to the receiver (research users). Therefore, the researcher must use languages that are clear and congenial to the background of the research users, statistical jargons should be discouraged. The researcher should be careful in the use of words, letters, graphical representations and the use of symbols in term of communicating of scientific results. In the model of communication presented above, there must be a sender (researcher) and a receiver (research user) .This implies that whatever message (research findings) is given, researchers should always expect a reaction or response (feedback) from the audience or receiver (research users).

In an effort to make communication of research findings effective, Nguyen (2014) identified what he called ‘The Power of Plain Language’ which explains creating information

that works well for the people who use it in print or online. Not every user will understand the vocabulary used in the process of research. The language then must be devoid of any ambiguity that may directly or indirectly affect the impacts of the research on any type of the users. In year past, scientist did not give due considerations to the effective ways of communicating their research findings, such that their languages were not congenial to the background of the receivers or audience, complexity within languages, grammatical structures were inadequate as well as presenting results.

As a result of these problems, scientific findings were not understood clearly by the public, and members of the scientific body. This alone made it difficult for the non-professional readers and the larger audience to pay limited attention to such findings. To the professional trainees, they had the difficulty to develop interest in the required field for progress in scientific and technological advancements because of their lack of understanding of the research findings. And to the non-professional readers, who sought too much knowledge to solve their day to day problems and also trying to be acquainted with the developments in the areas of science and technology, it was difficult to adapt to the result of the findings communicated to them.

It is in this way therefore, that this study seeks to discuss ways of communicating research findings particularly in Basic Science and Technology for technological developments. Also, its implications on professional trainees and non-professional readers so as to bridge the gap on how research findings were being communicated in the ancient past and cultivate the future in order to advance Scientific research in Africa. One can then raise the question: How can research findings benefit professional trainees and non-professional readers? Graham and Logan (2004) explained the process of effective utilization of research.



(Source: Graham and Logan, 2004)

Fig 2: Ottawa Model of Research Use

To assess the development process, credible developers, objective methods, careful documentation and local involvement are all necessary. The characteristics of the innovation to be assessed are relative advantage, compatibility, complexity, trialability and observability (Rogers, 1995). The innovation is the research report (output) to be transferred. Rogers (1995) identified five categories of those who would adopt the innovation as innovators, early adopters, early majority, late majority and Laggards. The target audience are the teachers, families, NGOs, formal decision makers etc. The barriers to the targeted audience (teachers) are knowledge/skills, awareness and attitudes. In assessing the practice environment, decision-making, policies, rules and laws, the technology available, physical layout, availability of evidence, work pressure and economic issues worth factors of consideration.

2. Diffusion of Innovation Theory

The advocate of this theory is Everett M. Rogers (Rogers, 2003). The theory tries to explain how innovations (research outputs) are taken up among specific group of individuals in a place over a time (Robinson, 2009). With reference to innovations, Rogers identified five categories of adopters. They are: Inventors (keen innovators, venturesome and educated), Early adopters (independent reinventors), Early majority (pragmatists, deliberate), Late majority (conservatives, skeptical and traditional) and Laggards (cautious, skeptical and they are stragglers).

Rogers (2003) put forward perceived qualities that help in the diffusion of innovation which are relative advantage, compatibility, simplicity, trialability and observable results. This implies that the degree of perception of relative advantage of innovations by intending users may determine how more rapidly its rate of adoption. That is, the greater the perceived relative advantage of innovations (research outputs) by the teachers, the more rapid their rate of adoption is likely to be. Also, there is the extent to which an innovation is viewed as being consistent with existing values, practices and needs of the adopters (compatibility). Take for instance, research outputs that are relevant to the users professional practices and needs (compatible) are more likely to be adopted rapidly than those that are incompatible.

Furthermore, research ideas, outputs/findings that are simpler to understand find themselves within ease of use than research findings that are perceived difficult to understand (simplicity). In addition, research findings that can be experimented (or has convincing tendency of being practiced) gain more possibilities of being adopted than those that cannot be experimented (trialability). Also, the ease with which the results of innovation can be seen leads to a likelihood of adopting the innovations with ease. That is, the easier it is for a user to see the results from research, the more likely he/she is to adopt them (observable results). When the research outputs are visible enough, peers also have tendency to discuss them among themselves. This further helps in seeing the need to adopt it by the majority.

According to Rogers (1962), a diffusion process follows an S-Curve in the adoption of innovation. This is represented below:

Slow change → Rapid change → Slow change

The adoption process (decision-making process) undergoes five stages:

- 1) Knowledge (initial knowledge/awareness of innovation)
- 2) Attitude (individual's negative or positive attitude towards the innovation)
- 3) Adoption/Rejection (individual's decision to adopt or reject the innovation)
- 4) Implementation/utilization (practice of the innovation) and
- 5) Confirmation (convinced of the certainty of the innovation)

3. Issues in Communicating Research Findings

Communicating research findings is an orderly and meaningful process of passing research discoveries and novel innovations to the public. According to Akpan (1987), as cited by Etim (2006) communication can be regarded as the understanding of how human beings take in information. Communication can be seen as science or an art (Etim, 2006). This researcher further explains that communication as an art involves the study of the process of selection, production and transmission of signs and symbols so that meaning of analysis and interpretation of the encoded message can be ensured. And as a science, it is known as communicology which is a systematic principle and techniques to the understanding of how human beings take in information. The principal essence of communication is to transfer message or information from a source (sender) to a receiver which in turns yields a feedback.

Similarly, communicating research findings to users, which include professional users, should be the concern of the researchers. These are the people belonging to the same field of specialization where the research has been conducted but may/may not understand the technicality of the coded results. Professional users also, include the people currently undergoing training from the same field of specialization of the researcher. The users also include non-professional readers who will like to be familiar with research outputs and apply it to solve their peculiar problems. In order to communicate science effectively, there is need to apply necessary scientific techniques and principle, to understand the audience or receivers of the information, and possible result of such scientific communications.

According to Greenwood (2001) and Leshner (2003) cited by Brownell, Price and Steinman (2013), communication of science to the general public increasingly recognize as a responsibility of scientists. Communication in Basic Science and Technology is essential because this is the basic and fundamental study of other science courses especially in Nigeria. In

communicating research findings, the type of audience should be taken into consideration, it should be determined whether with professionals, experts, professional trainees or non-professional readers or the general public.

In many schools in Nigeria, there are not enough Basic Science and Technology professionals. Many teachers from science related fields are co-opted to teach the subject. Many of these non-professional Basic Science and Technology teachers depend on research outputs both in print and online. These research findings should be communicated in such a way that the information given out will be useful and applicable by all audience. It is also imperative to note that the language used would determine the extent of usefulness of the information. The language could be the dialect, the grammatical structure, the context of usage, and so on. Developing skills in communicating scientific ideas at a level that users can understand requires deliberate practice and careful attention to language.

Balenson (2004) and Briscoe (1996) as cited by Miller (2006), suggest that in explaining your statistical methods of your research findings, keep your description of data and methods brief, providing enough information for viewers to follow the story line and evaluate your approach. Also, avoid clustering words (Miller, 2006) and much technical details or obscuring the key findings with excessive jargons. Explaining statistical method or other technical issues related to the specific concepts of study should be mentioned. Synonyms for technical and statistical terminology should be provided having in mind the type of audience the research seeks to attend to.

In addition, in reporting or communicating the result of findings, numerical values should be explained clearly stating the units, the magnification and directions using languages and examples that are congruent with the audience (professional readers) background. Science is increasingly interdisciplinary and the ability to communicate more effectively across discipline can help foster collaboration and innovation, advance scientific research, build support for science, promote understanding of its significant to the society, policy makers, governments and individuals especially in Africa.

4. Communicating Research Findings at Basic Education and Secondary School Science Levels

National curriculum for Basic Science and Technology recommends the process of inquiry to study science (NERDC, 2012) at Basic Education and secondary school levels. This has a lot of advantages. National Science Education Standards (1996) highlights the potentials of engaging students in inquiry process in that it helps students develop:

- Understanding of scientific concepts.
- An appreciation of "how we know" what we know in science.
- Understanding of the nature of science.
- Skills necessary to become independent inquirers about the natural world.
- The dispositions to use the skills, abilities, and attitudes associated with science.

During the process of enquiry/investigation or research at this level, the learners who happen to be the young researchers may come up with new knowledge, innovations or discoveries. The challenge of how to make this discovery known to the peer/peer teacher or public becomes visibly necessary and critical. Being the great researchers of tomorrow from what and how they are equipped today has a lot to do with what will be their contributions to scientific and technological developments. In order to build confidence in these young researchers to communicate their findings at local and international levels, the following are very essential:

- Literacy ability-They should have ability to read and write meaningfully and convincingly.
- Numerical ability-They should be able to use number to represent quantities
- Make graphical representations of results where necessary-Many students in science class of secondary schools do not know how to plot simple graph of variables from their weekly practical. Many of them are only exposed to practical in their final year because of certificate examinations.
- Must not be deficient in vocal power-They should be able to express themselves freely using simple and correct needed language.

5. Communicating Research Findings at Higher Education Level

Researchers at this level should make concerted efforts to communicate their findings effectively well. Considering the tedious process involved in carrying out research coupled with increasingly competitive and global market, researchers from various research institutions need to communicate their research effectively to both national and international communities. Researchers need the communication skills to enable them to make known their findings (British Council, 2013) to:

- Publish in reputable journals
- Present their findings at conferences
- Apply for funding to national and international bodies
- Communicate with the wider public and policy-makers and
- Build international collaborations to further their research.

Higher institutions of learning are equipped with resources that could promote conduct of scientific investigations. Procedural steps should be well explained and the results presented to benefit the users. The most common research reports among students of higher institutions at the end of the completion of their academic pursuits are project work, dissertation and thesis. In communicating their research findings either in writings or oral presentations in form of seminars or oral defense, students should carefully select simple, possibly words that have direct meaning and simple graphical illustrations. Students' supervisors should take time to go through students' research work, take time to pay attention to every detail of the work including semantics. He should reflect much of himself in the work being an expert of quality certificate and work experience.

In addition, students' work could be given to an editor to improve on the quality of the work. Students' teachers, that is, lecturers conduct lots of researches with many variables under control. Their results are communicated/presented at either local or international conferences. Others could be published in journals. Being basic academic environment, there is tendency on the part of the researchers to be influenced by 'big vocabulary' of the environment. This must be, to a large extent, be avoided.

6. Communicating Research Findings to Professional Trainees

According to Hornby (2015), a professional is a person who has a lot of skills and experience. Hornby further defines a trainee as a person who is being taught how to do a particular job. In combining the definition of the two words, it can therefore be inferred that a professional trainee is a person who is being taught special skill and experiences related to a particular profession. Therefore, it is necessary to consider professional trainees at all levels- Basic Education (Primary 1 to Junior Secondary School 3), Senior Secondary and Higher Education Levels so that effective communication of research findings will impact more skills and ideas of the profession, improve the professionalism of the trainee, encourage the spirit of further researches and so on. Professional trainees need information from research for their projects and some other important usage. Communicating research findings to professional trainees implies that:

- It impacts on the professional trainees more skills and experiences for their competencies
- It encourages in them the spirit of inquisitiveness and further research
- It enables them to make evidence-based decisions and use new scientific knowledge to improve their quality of profession
- It helps to maintain their participation in scientific research by targeting perfection of their profession
- Communicating scientific result finding effectively to professional trainees will also help to boost their confidence in the profession and scientific processes.
- It will also help to boost already acquired scientific skills and techniques

7. Communicating Research Findings to Non-Professional Readers

In contrast to the definition of professional trainees, non-professional readers are those who do not have professional skills and experiences of doing a job, or a particular specialized area. Communication of scientific result is really necessary to this group of people. They include the undergraduates, graduates professionals from the art and humanities, and the general public who do not advocate scientific ideas or explanation to their actions. They would want to find out new trends in scientific innovations and build their interactions around new knowledge or products. They may have their verbal or non-verbal contributions for further developments.

Communicating research findings effectively to this category of research users has some implications:

- It provides encouragement to non-professional readers to understand the natural world.
- It helps to take away fears and misconceptions about the natural happening around them
- It brings the world of inventions and discoveries near them
- Communicating scientific result will assist policy.

8. Recommendations

Based on the discussion in this study, it is recommended that:

- Government should intensify efforts in funding research and development
- Information and Communication Technology resources should be provided to all schools at all levels.
- Government/parent teacher association (PTA) should ensure appointment of more professional language (English) and mathematics Teachers in secondary schools.
- Teachers at lower and higher education levels should always encourage the students/professional trainees to carry out independent studies, practical, projects and prepare and present their results to their schools/institutions or for presentation in class using PowerPoint or verbally or through other means.
- Basic Science and Technology teachers and professional trainees should attend seminars, workshop and conferences for all round professional developments
- Innovations and new discoveries should be sponsored by individual philanthropists, government and organizations to advance technological breakthroughs.
- Scientific idea should be communicated using simple words
- Technical/complex Languages or terminologies and synonyms should be avoided when communicating research findings.
- Technical jargons/indirect propositions should always be avoided.
- Students' supervisors should take time to go through students' research work, take time to pay attention to every detail of the work including semantics. He should reflect much of himself in the work being an expert of quality certificate and work experience.

- Knowledge of the class or level of audience should be considered by publishers/authors of new knowledge/discoveries.

9. Conclusion

Communicating research findings effectively in Basic Science and Technology should be the concern of educational researchers. To improve on the past which must have been positive or negative, positive in the sense that the results were effectively understood and utilized by the users and negative in the sense that the results were not having much effect on the users. In Africa, scientific research findings are increasingly important and there is need to encourage the progress. In years past, scientists ignorantly used jargons and technical words that are not in consonance with the audience's background. Communicating research findings effectively in Basic Science and Technology is important in bridging the gap and advancing towards a an effective communication of research findings in Africa and beyond. This communication is not done haphazardly; it is an organized, prepared and planned exercise which aims at achieving specific objectives of better impacts and favourable feedback.

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