The Role of Communicative Competence in Effective Science and Technology Education

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Abstract
This paper recognizes the shortcomings of the educational system with regard to low standards and non-realization of set school aims, especially in the Science and Technology disciplines. Though several factors are responsible for the acknowledged disreputable situation, attention is drawn to the low proficiency of Nigerian Science and Technology students in the language of instruction as a basic obstacle to effective teaching and learning in the science and related disciplines. What it takes to be communicatively effective for optimal studies is explored in the examination of the language skills. Obvious linguistic impediments to teaching and learning in the sciences are highlighted. The paper concludes that the student of science or technology must be adequately competent in the language of instruction and the language of access to documented information in the area for any meaningful learning to take place. Recommendations aimed at overcoming the obstacles and making science and technology education effective and productive are proffered, a major one being that a credit level pass must be required for admission into any higher institution whether the field of study is science, technology, arts or any other. It is also recommended that the general Use of English Course Should be further strengthened and given more time and specialist scope to meet the needs of students in specific fields.

Introduction
Stating that the standard of education in Nigeria is very low is saying the obvious, belaboring an almost stale issue. But the fact that the situation has implication for the survival of the nation makes frequent recourse to the issue very necessary. It appears the huge financial and human resources being injected into the education system have no commensurate impact (of course, except negatively) on the corporate existence and well-being of our society. This necessitates the continuous attention being paid to ways of checking and correcting the trend.

The high expectations which the Nigerian school system has on science and technology education have been dismally betrayed. This appears more so when one considers the ever widening technological and economic gap between Nigeria and the western world and even some Asian countries that were slightly worse off than Nigeria only a few decades ago. South Korea, Malaysia, China, Taiwan, and India are a few examples. The difference is that these countries reaped the reward of their investment in science and technology education. The failure in Nigeria has been attributed to factors indicting the school system, the government, the general public and international conspiracy. The effort in this paper is to characterize the linguistic aspect of science and technology education and see what role it can play in the realization of the lofty hopes of technological advancement in Nigeria.

Science, Technology and Language Competence in Perspective

Science

In literature, science is much more easily characterized than defined. It is also not the intention here to go into detailed characterization of science, but the aspect which is relevant to the expressed aim in this paper will be given adequate attention. The McGraw-Hill Encyclopedia of Science and Technology (1987,p.109).) recognizes that "a science is characterized by the responsibility of making statements which are susceptible of some sort of check or proof". It goes further that "A pre-requisite to nearly every science is a suitable method of description of its subject matter. The language of such description must be capable of reproducing or recalling the subject matter with precision and uniqueness."

The essence of this statement is to show that by nature science is precise, concise and unique. Its expression or study must be done in a language that is precise and adequate enough to meet the concise descriptiveness of science.

Technology

Technology is described as systematic knowledge and action usually of industrial processes but applicable to any recurrent activity. Wikipedia (2013) sees Technology as "the making, modification, usage, and knowledge of tools, machines, techniques, crafts, systems and methods of organization in order to solve a problem, improve a pre-existing solution to a problem, achieve a goal, handle an applied input/output relation or perform a specific function". More succinctly, technology is seen as the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment, drawing upon such subjects as industrial arts, engineering, applied science, and pure science (Dictionary.com, 2013).

There is a very close link between science and technology. In some instances the two concepts have become so intertwined that they now represent a common concept. This much is acknowledged in the Encyclopedia of Science and Technology thus: "Technology is closely related to science and engineering. Science deals with human's understanding of the real world about them–the inherent properties of space, matter, energy, and their interactions. Engineering (technology) is the application of objective knowledge to the creation of plans, designs, and means for tools and techniques for carrying out the plans".

In pedagogical terms, technology or technical education would refer to the education aimed at equipping the recipients with the skills for acquiring tools and techniques for carrying out specific plans. UNESCO (1983, p.76) describes technical and vocational education as a comprehensive process involving, in addition to general education, the study of technology and related to sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life.

The National Policy on Education puts it more succinctly (and that is the sense in which technology education is taken in this paper): that aspect of education which leads to the acquisition of practical skills and applied skills as well as basic scientific knowledge (FRN, 2004).

Communicative Competence

Communicative competence has been variously defined. Campbell and Wales (1970) see it as the ability to produce or understand utterances which are not so much grammatical but more importantly appropriate to the context in which they are made. This description lacks adequacy for it ignores a basic aspect of communicative skill – linguistic competence. Hymes (1972) sees communicative competence as what a speaker needs to know in order to be communicatively competent in a speech community. Halliday (1975) made this more
explicit by outlining the functions a language possessed by a speaker should serve him. These include:

Instrumental – using language to get things done.
Regulatory – using language to control the behaviour of others.
Interactional – using language to create interaction with others.
Personal – the ability to express personal feelings and meaning.
Heuristic – using language to learn and discover things.
Imaginative – using language to create a world of the imagination.
Representative – using language to communicate information.

Communicative competence has four dimensions: grammatical, sociolinguistic, discourse and strategic competencies. Put together, these abilities will help the language user to make intelligible and situationally acceptable utterances, participate effectively in discussions, and adopt strategies to initiate, terminate, maintain, repair, and redirect communication (Canale and Swain, 1980). The whole essence is for the language user to be so skilled in the language that he is effective in the diverse communicative situations, saying precisely what he has to say to suit the content and situation.

Linguistic Requirements for Effective Science and Technology Scholarship

The Primacy of Language

Language is the vehicle of thought. Therefore, clear language helps and fosters clear thinking and precise expressions. Any human language has all its takes to express any conceivable idea. The creativity of a language user lies in his ability to give vent to his idea which will only be useful if successfully communicated to others. In the words of Moody (1970, p.21):

> The primary role of language is to facilitate communication, to promote understanding between language originator and language recipient, and to enable useful, appropriate and efficient action to take place.
>
> Communication and learning are so intimately related that whatever impairs or facilitates communication will impact negatively or positively on learning. Brooks and Warren (1972, p.5) aptly reflect the importance of language in self-fulfillment as follows:

Whatever a person's practical success, he will, if he lacks competence in language, spend much of his life fumbling in a kind of twilight world in which ideas, facts, and feelings are perceived only dimly and often in distorted shapes, hence through language man discovers his world and himself.

Language inadequacies, as implied in the statement above, pose a serious threat to educational and occupational aspirations. As long as performance in the language of

instruction is poor, performance on other subjects will remain abysmally intolerable. It has been observed that in the sciences, language may help or hinder a person in making correct perceptions of shapes, space, and relationships (Falokun, 1988). One can only infer from this that technological advancement is not possible without the appropriate communicative skills which centre around language proficiency.

The Science and Technology student has an added language hurdle in the pursuit of his discipline. In ordinary usage, a language contains the seeds of scientific and technical thinking and expression. A specialized language of science has the focus of enhancing effective and the most economic and concise communication, and above all, for universality. The specialized languages of the various sciences also permit statements to be made much more precisely than is possible with conventional language. But nobody can go straight into specialized language without mastering the common core upon which the specialized version is built.

Communication Skills in Productive Science and Technology Education

The various language skills are maximally involved in the acquisition and expression of knowledge involving the interaction of human minds. The differential attitude of teachers and students to the place of language proficiency in schools has continued to be the bane of improved academic performance. Science and Technology teachers and students tend to believe that they do not need to be good in English to perform well in their disciplines. This is gross disregard for the established fact that one's competence in the language of instruction determines his performance in other subjects. Many students at the secondary school level know little or no English, at times necessitating recourse to the mother tongue as a medium of instructions in certain situations. The fact that the students are not going to encounter the subject in any other mother tongue medium outside the classroom makes progress near impossible. The situation is barely different at the tertiary level of education, Akere (1995, p. 196) reports that at the tertiary level of education students have so much difficulty with their communicative skills that they cannot function effectively in their academic use of English. The concern the scholar expressed is the difficulty of achieving educational goals and objectives if the present communicative lapses are allowed to persist. The way out of the predicament is taking studies in language skills and use of English seriously.

The language skills – listening, speaking, reading, and writing – are the keys to effective communication in any language. In the English language the requirements are as follows:

Listening and Speaking (Oracy Skills)

Listening is described as a selective process of attending to hearing, understanding and remembering aural symbols. It is the primary source of language which serves as a base for the development of other language skills (Babuje, Mungvwat, Opara & Chigwong, 1988). Students need to listen effectively for overall improved language competency. Listening effectively will enable the learners to question, to sort, to organize, to evaluate, and to choose, thus becoming "rational consumers of auditory input". Speaking ability is the first implication of adequate listening. Without going into intricacies of speech, and admitting the handicap of a second language learner, especially in the Nigerian context, what is worth saying about speech production is that

the oracy skills will help the learner to communicate orally. Also, further development in language proficiency depends on them. The acquisition will help the student to understand when spoken to and to express his feelings and experiences in a way that is intelligible and convincing (Oyetunde & Muodumogu, 1999). The scientist has to possess a highly developed listening skill in order to maximize his observational ability. He also has to speak convincingly to sell his idea to the public.

Reading

Reading is a meaning – searching activity where the reader has to reconstruct the writer's message using textual clues alongside linguistic signs, familiarity with content and recourse to other relevant experiences at his disposal (Opara, 2012). Successful reading involves a lot of abilities. This, as clarified by Joffe (1988), include (i) basic comprehension, interpretation and organization skills; (ii) study skills and (iii) critical reading skills. Expanded, these skills contain the ability to find the main idea in a text, understand relationship of idea, determine the significant details and adopt appropriate reading technique like the SQ3R (Survey, Question, Read, Recall and Review) which makes reading systematic and provide instant feedback as to the effectiveness of the reading effort. They also include the ability to follow printed direction as in maps and charts, appreciate figurative language and make inferences about mood, tone, purpose, and point of view. For a reader desirous of success.

Williams' (1990) outline of comprehension skills is instructive. Broadly, the skills the reader requires are(i) literal (reading the lines); (ii) inferential (inferring deeper meaning or reading between the lines); and (iii) Evaluative (judging meaning and method or reading beyond the lines). The student must be adept at making the most gain out of the time spent on reading. The possession of such ability will make a science and technology student very effective and productive. To crown these skills, the student has to possess a healthy appetite for study, reading out of pleasure and desire, and not just because there is a duty that must be done.

Writing

Writing is considered the highest among language skills. Its acquisition presupposes a mastery of the linguistic patterns of the language in terms of grammar, spelling, punctuation, style and situation. The art of writing has to be consciously cultivated as the ability to speak a language does not guarantee the ability to write effectively in it. Writing effectively is "to say (in writing) exactly what one intends to say in the best possible way to suit the content and the situation (Opara, 1998, p.98). The sub-skills that make up writing ability are punctuation, spelling, outlining, paragraphing, logical sequencing of ideas, sentence linking, and specific writing formats (as in letters, reports, memoranda, reviews, etc). It is only when the basic writing skills are mastered that the scientist or technologist will focus on the requirements for writing his own type of reports. Necessarily, these will be specialized and will require a certain depth of technical competence. But it will not be difficult if the general faculty for writing has already been developed. In fact, it will be a mere extension of a skill already possessed.

Success in writing scientific and technical reports will make a first rate scientist or technologist. It is also worthwhile to note that this level can never be attained if total

language proficiency is low. And if this level cannot be reached, the scientist or student will remain a mediocre with still-born dreams and projects. Such a person will never contribute to self-improvement let alone national development.

Language Impediments to Effective Studies in Science and Technology

The English Language is the medium of instruction in Nigerian schools from the last three years of primary education to the tertiary level. The poor level of proficiency of the Nigerian users of English and its effect on educational standards are very obvious. The science and technology student has an additional burden because the already "strange" language is made to bear an even "stranger" message. Science and Technology as disciplines have their peculiar terms and sentence structures which can only be meaningful if the language in its conventional use has been mastered.

The above problem is further intensified by the low level of language competency of secondary school students who would eventually pursue studies in the sciences in higher institutions of learning. Despite the poor language background as is often shown in their school certificate results, the students still gain admission into these courses through the backdoor provided by the preparatory programmes prefixed with "Pre". The requirements for these programmes do not emphasize a pass in English for the science related disciplines, meaning that whoever manages 3 or 4 passes in SSCE is admitted to pursue studies in the sciences through the Pre-ND, Pre-N.C.E. or remedial programmes in the universities. However, it appears this problem is being addressed in some institutions.

Another serious deterrent to effective studies in the sciences is poor classroom communication. It is expected that the students must listen attentively, but the teacher must endeavour to use correct words and appropriate expressions to the level of the students (Okwori, 2002). Poor language habits like incorrect pronunciation, ambiguous expressions, wrong words, and superfluous usages hinder effective learning because they lead to breakdown in communication, a situation we see re-enacted daily in our science learning sessions.

If effective classroom communication is often threatened, the language in science textbooks offers glaring impediments to meaning reconstruction. It appears the writers are more interested in their content to the detriment of language use. The end results are usually that the students are given "monsters" in the name of books which will only confirm the notion that "science is difficult", a notion that mediocre scientists tend to celebrate. The truth, however, is that over – reliance on scientific jargons, at times, hides lack of knowledge or inadequate grasp of the subject matter.

All the factors above culminate in the unwholesome attitude of the vast majority of science and technology teachers and students. The teachers condone sloppy language from the students probably because the students to some extend get it from their teachers. This has led to language habits that are so poor that communication outside the classroom or involving other sets of participants is seriously impeded.

Conclusion and Recommendations

This paper has shown the vital role the language of instruction plays in effective learning with particular reference to studies in science and technology. It is also clear that there will be no meaningful impact of science and technology learning if the language skills required for receptive and productive communications are not consciously cultivated, acquired and applied. The obvious linguistic constraints on studies in the sciences and related disciplines have been identified. The strategies for their total reversal constitute the following recommendations.

There should be strict adherence to the requirement of a pass at credit level in English for admission into all tertiary institutions. At least, a compulsory pass in English for Pre-ND or Pre-N.C.E. admission should be required. Though the prevalence of exam malpractice may thwart the aim of getting only students with an acceptable level of proficiency in English admitted, it is better than flinging the gates open to all comers.

A necessary second step is to make the teaching of communication skills more effective. This will be done by involving more qualified language teachers so that close attention will be given to students in smaller groups to ensure effective drills on the skills required for optimum performance in language use.

There should be a radical change in attitude towards English as a compulsory general course. It is not a course that should be half-heartedly attended to as it impinges directly on learning outcomes in other subjects. As a skill-equipping service course, it should be taken seriously by learners and their teachers in the various departments, and not as an unnecessary appendage – as it is currently taken to be by students and some of their departmental teachers.

Textbook writers and teachers should pay more attention to language use. Since the contents of science and technology are somewhat fixed, the focus of teachers and writers should be on how best to put these across. Even when instructional resources that will facilitate learning are available, the language used in further explanation, assessment and feedback will highly impact on learning outcomes.

The Nigerian child should be exposed as early as possible to good English alongside any other language used in the home. The target is to make the child so bi-lingual in English and his mother tongue that both will serve him in first language capacities. This will enhance the child's ability to think and grasp concepts in English which is going to serve him for the greater part of his life. It is on this ground that the private school systems start their pupils straight on English from the Kindergarten have an edge over the public schools which adhere to the "mother tongue for first three years of primary school" policy. It is a fact students from private primary schools perform better than those from public schools. They are the ones that easily gain competitive admissions into highbrow private or public secondary schools.

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