

# The Relation between Language and Science, Technology, and Mathematics in Nigerian Schools

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**Abstract**—The study focuses on importance of language proficiency in the learning of science, technology and mathematics (STM) with attention given to the review of research studies on language and STM within the context of the debate on choice of mother tongue as a language of instruction in Nigerian schools. The obvious bias on the continual use of the English Language as a medium of instruction in STM at the secondary school level is evident. The discussion was supported with the report of a study in which students' performance in English Language, and in each of mathematics, biology, chemistry, physics, technical drawing, further mathematics and agricultural science in the West African Senior Secondary Certificate Examinations (WASSCE) were correlated. Also, students' performance in Yoruba Language (an indigenous language) and in each of Mathematics, Biology, Chemistry, Physics, Technical Drawing, Further Mathematics and Agricultural Science in WASSCE were correlated. The findings revealed significant positive correlation between English Language and each of the six STM subjects. Also there was a significant positive correlation between Yoruba Language and each of the six STM subjects. Mathematics and agricultural science had the strongest relationship with English Language, a trend observed with Yoruba Language. While English Language should continually be used as a medium of instruction in STM classes at the secondary school level, Nigeria should strive to develop one of her numerous indigenous languages not only to serve as a lingua franca but as a medium of instruction in STM classes.

**Keywords**—Language, science, technology, mathematics, Nigerian schools.

## I. INTRODUCTION

Science, Technology and Mathematics (STM) are all about communicating ideas [25] and communicating STM involves imparting, transferring or putting across ideas, concepts, skills, values and body of knowledge of STM specifically from the teachers to the learners [37]. Communication between the STM teachers and the pupils involves verbal and non-verbal strategies [34, 38]. The verbal strategies involve items (such as giving direction, use of humour, asking questions, use of praise and encouragement, cautioning when necessary to promote concentration, and use of appropriate voice inflection) which are designed to make the teaching of STM interesting, tension-free and void of noise factors or barriers [34] and verbal communication refers to spoken communication [24]. The non-verbal strategies include behaviours, which the STM teachers are expected to exhibit, using parts of their bodies (eyes, hands, legs, etc), so as to bring about effective communication [34] and non-verbal communication is the unspoken kind of communication [24] including items such as the use of physical movement, appropriate eye contact, and gestures. At the school level in Nigeria, various verbal and non-verbal strategies proposed for effective teaching and learning of STM can be classified into language and technology of communication. The use of oral language can be verbal, using human speech for lectures,

discussion, problem solving, and as tutorials. The technology verbal strategy connotes interactions between the teacher and the learners through the use of technical devices such as telephone, radio, television, tape recorder/player, etc [38]. The non-verbal language strategies include the use of handouts, audio-visual, teaching materials, practical work, books, articles, references, kinesics (for the deaf and dumb), movements, documents, laboratory, behaviour etc. The technology non-verbal strategies embrace the use of telegram, fax, telegraph, projector, video player, scientific calculator, computer, satellite, e-mail, Braille machine (for the blind), and social media networks such as facebook and twitter. Language is the meeting point between STM and communication. STM have to be communicated through language and language, as a system and vehicle of communication [32] is an integral part of thought [23] and to Homo sapiens, it can be in the form of speech or written symbols [25] without which the Homo sapiens will find it difficult if not impossible to exist [32].

Language is considered a critical resource in all human endeavours, especially in the educative process [31] and this supports the view that language is a resource human beings use in the configuration and organization of their experience as well as in building information, attitudes, ideas or points of view. Language performs three basic functions of informing, expressing and directing [45], thus, it is regarded as the vehicle of learning and proficiency in the language of instruction facilitates learning [31]. The language of STM is distanced from vernacular language for STM involve logical chains of arguments, couched in abstract and specialized language. STM language skills include the ability to read with comprehension, to express scientific, technological and mathematical thoughts clearly, to think logically, and to recognize and use common pattern of scientific, technological and mathematical thought. Language has a connection with thinking in that a person's ability to think in an elaborate and abstract way is a product of the ways in which he/she has used language, especially spoken language, as a child [25].

## II. PROFICIENCY IN LANGUAGE, AND STM EDUCATION

According to [44], the characteristics of the language habits that are being acquired and the kinds of functions the language serves in the child's experience actually shape his/her intellectual development, especially the development of the ability for abstraction and conceptual learning. He adds that poor development of this ability places a low ceiling on a child's educational attainment. In this respect, the interactions between language and STM are being analysed. Developing effective language skills by learners of STM has been a major pre-occupation of STM researchers. Reference [42] noted that one of the essential conditions for comprehending and interpreting scientific phenomena, concepts and facts is the development of effective language and communication skills by learners. In his study of comparison of candidates' performance in Senior Secondary Certificate Examination

(SSCE) in STM with those obtained in social science, arts and liberal arts subjects, [42] revealed that the candidates did not understand the questions they were answering. Consequently, the low level of STM achievement which occurred during the three-year period of [42] review (1988-90) was attributed to defective and very poor language skills. Who writes better English, the science or arts students? This question was the crux of a research by [26] whose investigation was in three prongs: (i) which of arts or science students made fewer errors in their written English, (ii) which type of errors each category of students frequently made and (iii) what are the possible causes of these errors and what are the implications in the teaching of English as a second language in Nigeria? The results showed that of 4,636 errors committed (by 200 randomly selected senior secondary school year two students), and classified into 20 categories of grammatical, structural or syntactic nature, arts students made more errors in both the elicitation and diagnostic tests. It was only in six categories of errors that science students had higher scores in frequency counts than arts students. Reference [30] looked at the language problems of some science student teachers in the university. She assessed the type of language for teaching 300-level undergraduate science education students over a period of 12 weeks using an observation schedule. Results revealed that 80.3 percent of the study sample committed errors, which ranged from spelling mistakes to structurally distorted grammar that may lead to misconceptions on the parts of students. It was recommended that even though students of tertiary institutions have passed English at the ordinary level, the use of English as a course should be made core and compulsory at every level until the students graduate. This, hopefully, will enhance teaching and understanding of ideas and concepts in STM. Reference [29] examined the relationship between proficiency in English language skills of composition, reading comprehension and grammar and achievement in elementary Mathematics in Nigeria. Results showed that at the primary five, significant relationship was found between pupils' reading comprehension scores and Mathematics scores and no such significant relationship was found in primary four. Higher and significant coefficients of correlations were found between language, comprehension, grammar, and total English and Mathematics scores at primary six. According to the researcher, one plausible explanation for the results of the study is that primary four is a transitional stage at which native language is used to complement English language as a medium of instruction. Whereas in primary six, where the medium of instruction is essentially English, the language is bound to play a dominant role in the learning of mathematics taught in English. The clamour for the adoption of mother tongue as a language of instruction in Nigerian schools became concretized in the late 1960s with the birth of the "Ife Six-Year Primary Project" considered a veritable solution to the teaching/learning problems experienced by the Nigerian children's use of English in schools. The University of Ife (now Obafemi Awolowo University) Six-Year Project designers taught all primary school subjects including Science and Mathematics,

except English, in Yoruba language. English was taught by specialists of the language. The designer of the project hypothesized that (i) the pupils taught in Yoruba would perform better than those taught in English in science, mathematics and social studies; and (ii) in English, that the pupils taught in Yoruba will not be worse off than the others. However, the result of the six-year primary project has proved unequivocally that the mother tongue, if given the right impetus will go a long way in enhancing pupils' performance in the various school subjects including science, technology and mathematics.

Reference [43] has also revealed that pupils taught entirely in Yoruba in the primary school have had no problems of adjustment in secondary schools, where the medium of instruction is entirely in English. Reference [32] reiterated that children taught in the mother tongue are less inhibited in class, and tend to participate more actively in classroom activities and discussions and tend to perform better in test of reasoning than those taught in English. Reference [17] has established that students and teachers consented that science should be taught to Nigerian students in Nigerian languages and so this was considered as a veritable solution to students' under performance in science. In their study, remedying student's underachievement in science through the use of mother tongues as a language of instruction, [18] exposed some junior secondary school (JSS) students to treatment of teaching integrated science in Yoruba language as the experimental group while the other group-control was exposed to the teaching integrated science in English. The results showed that the experimental group performed significantly better than the control group. This finding was in agreement with earlier findings of [13, 14, 15, 22] with primary secondary schools. In a similar vein, [6] compared students' achievement in elementary science between pupils who were taught in Yoruba language and those who were taught in English language. He found out that pupils taught in Yoruba performed significantly better than those taught in English language. Similar finding were recorded by [21] though with sample of pre-adolescent Igbo students in Physics that the use of Igbo language facilitated higher students' performance and more favourable student's attitude towards physics than using English language.

Reference [12] conducted a longitudinal experimental study on primary school pupils in which some pupils were taught all the school subjects in the mother tongue while another set of pupils were taught in English language. The results of the pupils in their first school leaving certificate examinations did not show any statistically significant differences. Though, in the interim, at the end of primary three and primary four, some differences in performance were observed between the two groups in some subjects excluding English language. It was thus concluded that it is not enough to teach throughout in mother tongue even if we must help the students to understand science. We need to make the pupils get used to the scientific terminologies as we have them in English.

In furtherance of the penchant for encouraging every Nigerians child to learn one of the three major languages;

Hausa, Igbo and Yoruba as a way of preserving the people's culture as contained in the National Policy on Education [11], [32] noted that it is the study and use of our indigenous languages that will enable us to really preserve our cultural heritage and not the use of a foreign language. It is high time we started thinking of replacing English which has become Nigerians lingua franca with at least one of the major national languages. The myth that the multi-lingual nature of Nigeria constitutes an insurmountable impediment in the way of formulation and implementation of an effective programme for the integration of our indigenous languages in the process of development and nation building is easily demystified by experiences of other nations. In Tanzania, for instance, Kiswahili which is an indigenous language is not only the medium of instruction in the country's educational system (at the primary and secondary levels of education), but it is also the official language. Other examples are multilingual Guinea, Yugoslavia and Switzerland as well as Bilingual Canada.

Another twist to the adoption of indigenous language in STM education is given by [27] in their quest to establish standardized scientific registers in the mother tongue from the interpretative responses of junior secondary school pupils and teachers on scientific concepts. A list of 100 science concepts was randomly drawn up from the Nigerian integrated science Projects I and II. This is to enable pupils and teachers to give meanings in English and provide appropriate conceptual words in their mother tongue. Yoruba and Igbo were the major indigenous languages used. Analysis of pupils' and teachers' conceptual meanings in English language and the assessed terminology showed contrasts in the meanings and terminologies used by pupils and teachers. The teachers in Yoruba could translate more than 40 percent of the terminologies, and another 40 percent in Igbo could not be translated. With this results, [27], argued in favour of strengthening the 'use of English' course for teacher trainers, especially in science, technology and mathematics education.

Reference [24] investigated the teachers' attitude to, and of extent of utilization of verbal and non-verbal strategies for effective communication of environmental concepts in biology with 50 biology teachers from 40 randomly selected secondary schools in Oyo State, Nigeria. The result showed that: (i) the teachers' attitude towards the use of language strategies (verbal and non-verbal) was favourable (weighted mean scores, wms = 2.80); (ii) The teachers' attitude towards the use of technology strategies (verbal and non-verbal) was unfavourable (wms = 2.09); (iii) the female biology teachers possessed greater significant attitude mean score than their male counterparts in their use of language verbal strategies like lectures, discussions, etc; (iv) the male biology teachers possessed greater significant attitude mean score than their female counterparts in their use of technology, language non-verbal and technology non-verbal strategies; (v) the teachers' use of technology strategies (verbal and non-verbal) was very low wms = 1.61; and (vi) there was a significant difference between the males and females in their use of technology verbal and non-verbal strategies: the males outperformed the females in their use of electronic media for

biology instruction. It is however compelling for both male and female teachers to attain a good verbal and non-verbal proficiency level in order to communicate and share ideas, feelings, thoughts and skills entailed in science communication processes [24] as well as technology and mathematics communication processes.

Reference [33] examined an aspect of the language of science that involves communicating ideas by the use of formulae with 330 junior secondary school year three integrated science students of mixed gender and ability randomly chosen from eight co-educational schools in Lagos State, Nigeria. Their findings revealed that students exhibited very low levels of achievement on the integrated science test signifying that they had problems in the writing, interpretation and application of science formulae. This led credence to researchers who have found that the language of learning actually mediates learning [41]. Therefore, it is necessary to develop students language of learning in terms of both the meaning of words related to learning and their use [40]. Reference [35] investigated the influence of mother-tongue, teacher's qualification, gender, and experience on pupils' performance in primary school mathematics in Katsina State, Nigeria within a pre-test and post-test quasi-experimental non-equivalent control group. Results showed that the use of mother tongue (Hausa) as medium of instruction enhanced the performance of pupils in primary school mathematics. The claim that STM students need not master a particular language after all, all they need to know are facts and formulae is absolutely incorrect. This is because it is particularly impossible to acquire scientific, technological and mathematical knowledge of different dimensions without verbal reasoning- a component of language. Thus, language remains a vital communication tool in the teaching and learning of the universal concepts and rudiments of STM. This undoubtedly has made English language an official language in the Nigeria context to the extent that a credit pass in English language is a prerequisite for admission into all Nigerian universities regardless of the proposed course of study.

### III. PURPOSE OF THE STUDY

The purpose of the study was to present a discussion on the choice of language of instruction in the teaching of STM at the secondary school level in Nigeria within the context of a correlation research. The relationship between students' performance in SSCE English and performance in each of the basic STM subjects (Mathematics, Biology, Chemistry, Physics, Agricultural Science and Technical Drawing) offered was investigated. In addition, the relationship between students' performance in SSCE Yoruba and performance in each of the basic STM subjects offered at the secondary school level was examined.

### IV. METHODOLOGY

The study adopted the correlation research design using an ex-post facto type. This is because data were collected from the existing school records which required no manipulation of the independent variable if any. The target population for the study consisted of all the Senior Secondary School Certificate candidates in Epe Local Government area of Lagos State, Nigeria in 2010. The sample for the study was selected through random and purposive sampling techniques across 14 schools in the local government area. It is judgmental in the sense that for a candidate to participate in the study, he/she must have taken Yoruba, Biology, Chemistry, Physics, Technical Drawing, Agricultural Science and Further Mathematics together in the SSCE. Mathematics and English Language are core compulsory subjects. Also, the schools involved must have presented candidates for the external examination conducted by the West African Examinations Council (WAEC) in 2010. Out of the 51, senior secondary schools in the local government area at the time of the study, 23 were found offering science courses. Out of the 23 science-based schools, only 14 met the aforementioned criteria. The eight schools that participated in the study were then selected randomly from the 14 schools. Simple random sampling technique was used to select candidates that took part in the study and the sample consisted of 322 STM based students (170 males, 158 females) with average age of 17.9 years. The collection of secondary data for the study was made by the researcher and two research assistants who went round the selected schools to collect the final SSCE results of the candidates (who sat for the) 2010 external examination conducted by the WAEC. The correlation between candidates' performance in English Language and each of Mathematics, Biology, Chemistry, Physics, Agricultural Science, Further mathematics and Technical Drawing was estimated using the Pearson product moment correlation (PPMC) at significant level of 0.01. Also, the correlation between candidates' performance in Yoruba language and each of the STM subjects was estimated using the PPMC.

### V. RESULTS

The results of this study are presented according to research questions asked.

1) *Research Question One:* Is there any significant relationship between the students' performance in SSCE English Language and each of Mathematics, Biology, Chemistry, Physics, Agricultural Science and Technical Drawing?

Table 1 below shows the correlation coefficients between students' performance in SSCE English language and each of the basic STM subjects. The correlation coefficients between English language and each of Mathematics, Biology, Chemistry, Physics, Agricultural Science and Technical Drawing were each statistically significant with  $r = .762, .582, .520, .591, .648, \text{ and } .588$  respectively at .001 level of significance. Hence, there was a statistically significant relationship between performance in English language and

performance in each of the basic STM subjects in the senior secondary certificate examination.

TABLE 1  
CORRELATION RELATIONSHIP BETWEEN STUDENTS' PERFORMANCE IN SSCE ENGLISH LANGUAGE AND EACH OF MATHEMATICS, BIOLOGY, CHEMISTRY, PHYSICS AGRICULTURAL SCIENCE AND TECHNICAL DRAWING

Subject	E	M	B	C	P	AS	TD
English (E)	1	.762	.582	.520	.591	.648	.588
Math (M)	.762	1	-	-	-	-	-
Biol (B)	.582	-	1	-	-	-	-
Chem (C)	.520	-	-	1	-	-	-
Phy (P)	.591	-	-	-	1	-	-
Agri.Sci (AS)	.648	-	-	-	-	1	-
Tech. D (TD)	.588	-	-	-	-	-	1

2) *Research Question 2:* Is there any significant relationship between the students' performance in SSCE Yoruba Language and each of Mathematics, Biology, Chemistry, Physics, Agricultural Science and Technical Drawing?

Table 2 below reveals the correlation coefficients between students' performance in SSCE Yoruba language and performance in each of the basic STM subjects. The correlation coefficients between Yoruba language and each of Mathematics, Biology, Chemistry, Physics, Agricultural Science and Technical Drawing were each statistically significant with  $r = .504, .324, .304, .401, .644,$  and  $.484$  respectively at  $.001$  level of significance. Thus, statistically significant relationship existed between students' performance in SSCE Yoruba language and performance in each of the basic STM subjects.

TABLE 2  
CORRELATION RELATIONSHIP BETWEEN STUDENTS' PERFORMANCE IN SSCE ENGLISH LANGUAGE AND EACH OF MATHEMATICS, BIOLOGY, CHEMISTRY, PHYSICS AGRICULTURAL SCIENCE AND TECHNICAL DRAWING

Subject	YL	M	B	C	P	AS	TD
Yoruba Language (YL)	1	.504	.324	.304	.401	.644	.484
Math (M)	.504	1	-	-	-	-	-
Biol (B)	.324	-	1	-	-	-	-
Chem (C)	.304	-	-	1	-	-	-
Phy (P)	.401	-	-	-	1	-	-
AgricSc (AS)	.644	-	-	-	-	1	-
Tech.Drawing (TD)	.484	-	-	-	-	-	1

Two major findings emerged in the study. First, the study showed significant positive correlation between English language and each of the six STM subjects (Mathematics, Biology, Chemistry, Physics, Agricultural Science and Technical Drawing). Specifically, mathematics and agricultural science had the strongest relationship. This finding agreed with the previous finding of [1] which revealed that English language correlated positively and strongly with mathematics followed by Physics, Chemistry and Biology in that order.

Second, there was a significantly positive relationship between Yoruba Language (an indigenous language spoken mainly in the south-west geo-political zone of Nigeria) and each of the six STM subjects. In essence, Agricultural Science and Mathematics had the strongest relationship. This finding corroborated earlier finding in this study and also in agreement with the finding of [1]. The findings in this study showed that it is not enough to teach throughout in English even if we must aid the students to comprehend STM. We need to incorporate Yoruba language in the teaching of the STM subjects since positive correlation exists between performance in mother tongue and performance in each of the STM subjects. Also, we cannot afford to teach STM subjects using local language (mother tongue) without any recourse to English language. This is because some scientific, technological and mathematical concepts like atom, cell, X-ray, quantum, square root, cube root, polynomial, etc, cannot be satisfactorily translated and defined in the various mother tongues in Nigeria. This submission is in line with [3] who pointed out that, we cannot use only local language without using English language to teach science subjects effectively.

At the moment most Nigerian learners use their mother tongues in relating to other learners who speak their language even in school settings and it is the desire of many Nigerian educators that mother tongues be adopted as language of education, after all there are a good number of nations whose indigenous languages are used at all levels of education. Germany, Japan and France for example, are known worldwide for their prowess in scientific, technological and mathematical inventions, yet each of these nations uses their indigenous languages as language of education in all their schools. It is more interesting to note that all nationals of each of these nations speak the same language meaning that there is no communication barrier among each of the nation's respective nationals. Unfortunately, Nigeria is a multilingual nation with many diverse ethnic groups and tribes speaking different languages. It is on record that Nigeria has between 400 and 513 indigenous languages spoken in different parts of the country [32]. This is a great challenge to every Nigerian child to communicate effectively within the society. Learners in the school as a microcosm of the society are also faced with more daunting challenge. For instance, every Nigerian pupil in primary one to three has to automatically contend with five different languages: the official language (English), the language of immediate environment (mother tongue), another Nigerian national language (Hausa, Igbo, or Yoruba), the language of mathematics, and the language of science and

## VI. DISCUSSION AND CONCLUSION

technology. Every pupil in primary four to six and junior secondary year one to three is caught in the web of five different languages as he/she tries to comprehend STM. These languages are the official language (English), French as a school discipline, the language of immediate environment, the language of mathematics, and the language of science and technology. At the senior secondary school level, every Nigerian STM learner will have to contend with four languages namely: the language of instruction at school (English), the language of science and technology, the language of mathematics, and the mother tongue of the learner. It is clear that poor mastery of the language terminologies tends to make mastery of other subjects in the school curriculum problematic. Thus, efforts should be made to facilitate learner's acquisition of language terminologies as precursor to attaining better performance in STM subjects and achieving desirable scientific, technological and mathematical literacy.

It is no gainsaying that mathematics is not just a school discipline but a language like English or Yoruba or Latin and even it is the only language shared by all human beings regardless of culture, religion, or gender. This is so because mathematics shares the 13 properties of a language enumerated by Osgood as noted in [23]. While maintaining that there are certain concepts for which mathematics is particularly suited, [39] says it would be as foolish to attempt to write a love poem in the language of mathematics as to prove the fundamental theorem of algebra using the English language. Mathematics is a universal language we use to identify, describe, and investigate the patterns and challenges of everyday living and mathematicians work to find the most powerful ways to communicate a chunk of extremely complex information in a limited amount of time and space taking advantage of spoken, phonetic, and symbolic languages and graphic images [23]. Mathematics is a specialized language of the sciences and according to [1], it is a language through which scientists and technologists express their ideas, laws and principles for mathematical symbols in science and technology are themselves mathematical vocabulary. Thus, communicating STM in a language that is alien to the learner can lead to intellectual fight emanating from disparities between the languages of science and learner's indigenous language. A way out of this language jam and conflict is stipulated in the National Policy on Education [9, 10, 11]. The fourth edition of the National Policy on Education states in section 4-paragraphs 19(e) and (f) that: the medium of instruction in the primary school shall be the language of the environment for the first three years. During this period, English shall be taught as a subject. From the fourth year, English shall progressively be used as a medium of instruction and the language of immediate environment and French shall be taught as a subject. In these two paragraphs, English language (which is foreign) and Nigeria's lingua franca is to be introduced to the pupils gradually in a transit manner. This is thus laying the foundation for English language to be adopted fully as the language of education in secondary schools and beyond. Educators have queried the

implementation of this aspect of the policy [1] in that till date, no concrete agreement has been arrived at on when indigenous language should start or stop among different school proprietors in the country [19]. The non-compliance to the policy requirements is hinged on the argument that pupils on completion of six years primary schooling, will transit to secondary schools where they will be exposed to more abstract and conceptual subjects like mathematics, physics, biology, chemistry, technical drawing, agricultural science etc at later years using English language as the medium of instruction while also studying English language itself as a core compulsory cross-cutting subject. In the long run, the students with mixed linguistics background are exposed to cognitive, affective, and psychomotor skills inherent in all these STM subjects using English language as a major communication tool.

In spite of the bold attempts made by scholars in STM education, the performance of students in the Senior Secondary Certificate Examination (SSCE) in STM subjects falls below expectation. The poor performance of students in STM subjects at the secondary school level in both internal and external examinations has been regarded as one reason Nigeria still remains underdeveloped among the comity of nations [1]. This poor performance has been partly ascribed to the language of instruction through which students are taught since the medium of communication determines to a large extent the success or failure of any curriculum. The results of the present correlation study presented earlier pointed to the fact that students' performance in any of the STM subjects was closely related to their performance not only in English language but also in Yoruba language. While these results conformed with the school of thought that advocates a mixture of mother tongue and English language in the teaching of STM and other school subjects [1, 3, 12, 25], another school of thought mostly championed by [6, 7, 13, 14, 15, 17, 22] and others believed that STM and other school subjects should be totally/purely communicated in the mother tongue. This is against the third school of thought which reckons with the teaching and learning of STM and other school subjects purely in English language. Prominent representatives of this school of thought include [27, 30]. However, English language has come to stay in Nigeria as the lingua franca and the language of education and commerce that cuts across all communication barriers at the local, national and international levels. Apart from being the most widely used language with attendant economic and political influence in those who speak the language [36], over 50 percent of the world's scientific literatures are written in English language, meaning that it is a language needed for economic and technological development [1] and prosperity of a nation like Nigeria. This is not to say that Nigeria should not strive to develop one of her numerous indigenous languages as a lingua franca to the status of English language at least in the country.

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