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SCIENCE AND TECHNOLOGY IN DEVELOPMENT

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ABSTRACT

This paper appreciates that science and technology are both important in the modern world, but points out that a situation where more emphasis is placed on the applied sciences or technological education over the pure sciences is unbecoming. This is because the pure sciences constitute the foundation of modern technology. It is, therefore, argued that it will be extremely difficult to make progress in technological and vocational education when the pure sciences are neglected. Secondly, and more importantly, science plays a central role in the modern culture of the world. The view is, therefore, posited that proper science education must be cultivated both for the advancement of human culture and for technology.

Keywords: Development, Science, Technology.

INTRODUCTION

Human beings have always made efforts to understand nature and their environment. These are reflected in myths, legends, folktales, cosmogonies and cosmologies of the various communities and peoples which are usually formulated on the basis of the common experiences of the people.

These formulations begin to appear scientific by the time human rationality is being applied to evaluate the common experiences of human beings. Thus, although science commences with sense perception, it goes far beyond ordinary observation or mere appearance. It can be said to be a concerted effort to get at reality by understanding and appreciating some latent but salient factors which are responsible for the way things actually are.

It is also a truism that human beings are confronted with several existential problems. In an attempt to overcome these problems, several techniques have been adopted and different inventions have been made. These various tools, irrespective of how crude they may be, which emanated from such inventions form the genesis of technology. Both science and technology have been in existence for a very long time, albeit they do not possess a common origin. In recent times, howbeit, they have become complementary to each other: scientific principles have played important roles in technological inventions and innovations, while technological equipment have been central in scientific investigations. Aside from its vital role in modern technology, the real essence of science is cultural.

Humanly speaking, the methodology of science is the most rational and the most coherent approach to evaluate human activities. It

provides the standard by which enlightened minds appraise the various aspects of culture. Given what has been presented above, the study of pure science, as an end in itself, is essential.

METHODOLOGY

The approach of this paper is conceptual analysis. It aims at clarifying the concepts of science and technology, and shows that, contrary to the commonly held notion, technology is not an offshoot of science. In fact, technology is older than science which proves beyond doubt that it can exist without science. However, their fusion in modern times makes the study of science inevitable. Critical analysis has also established that aside from the utilization of science in technology, its actual essence is the development of human culture. Conceptual analysis or clarification is a philosophical approach to research which aims at facilitating a concise understanding of given key terms. For this reason, conceptual analysis seeks to make known the etymological background, conventional usage, as well as contextual applications. For our purpose, the terms to be clarified are science and technology; what is their genesis? how do they relate with each other? and how do they affect the human society, vis-à-vis development?

Distinguishing between Science and Technology

As noted above, both science and technology are very old and cannot be said to have a common origin. It would also be false to believe that one was, *ab initio,* derived from the other. In modern times, science is conceived as that form of knowledge that is objective, durable, impartial, systematic and stable. The Greeks referred to it as *episteme.* It is the standard or measure by which other forms of knowledge are evaluated. For this reason, we hear of social sciences and human sciences. Among other things, science should be critical and aim at accuracy of observation of things and events. It can be presented as a systematized body of knowledge derived form observation and the testing of facts.

The desire to give account of the constitution of things in the universe or to explain the origin of the universe itself is very old and present in every known human society. A very famous case in point is the *Biblical* account of the origin of the universe and human beings, that is, the *Biblical* theory of creation. The *Quranic* account is also well known. Several other religions, myths and legends have elaborate explanations of the origin of the universe or how human beings came into existence. Right from the earliest times human beings have always made efforts to understand their environment and their entire cosmos and provide answers to a lot of other vital questions about life, the world and ultimate reality. The purpose of the various mythological stories was to provide a precise explication of the essential constituents of nature in order to facilitate comprehension. It can easily be seen that this mythological attitude is akin to scientific thinking. Pure science, as an academic field of study, is an effort to appreciate and understand the true nature of things, the entire cosmos and life itself. Its main purpose is to expand human culture and the worldview of human beings to bring about a fuller awareness and self-realisation.

On the other hand, technology is concerned with the problems of human existence, such as food, shelter, clothing, aesthetics, etc. Under common parlance, technology can be said to mean a systematic application of sci-

entific knowledge or the techniques and ideas generated from science. But, this is a later development because the term technology was hitherto used to describe the processing of raw materials. According to Tomovic (1982):

> **The term technology has had an interesting evolution. Originally, it was used to refer to the processing of raw materials. However, production turned out to be but one small aspect of the resources and activities involved in successfully running an industrial organisation. Gradually, awareness grew that a combination of scientific knowledge and accumulated experience is necessary to run any large system, no matter its nature. Thus, with the evolution of modern society, technology's role has increased enormously in depth and in scope (p.52).**

It is important to note, hence, that the scientific knowledge referred to above started taking shape in the 16th century in Europe. Before this time, however, both in Europe and several other parts of the world, many technological innovations had taken place. By way of an instance, what can be regarded as the greatest technological invention ever made by man, namely paper[2], was invented in China (Hart, 2005, pp 66-71). Kuhn (1981) made the following observation:

> **Every civilisation of which we have records has possessed a technology, an art, a religion, a political system, laws, and so on. In many cases those facets of civilisation have been as developed as our own. But only the civilizations that descended from Hellenic Greece have possessed more than the most rudimentary science. The bulk of scientific knowledge is a product of Europe in the last four centuries. No other place and time has supported the very special communities from which scientific productivity comes (p. 135).**

From the quotation above, it is obvious that science and technology have their separate origins. Greek thought played a fundamental role in establishing the scientific culture. Take for instance, the Egyptians and the Babylonians were early observers of the celestial bodies and over a long period of time became able to make correct and precise predictions concerning the heavenly bodies. In practical astronomical predictions, they were ahead of the Greek people, but yet the astronomical formulations of the Greek people of old played more important roles in the eventual development of the science of astronomy (Toulmin *et al.*, 1961, p. 61). Also the civilisation of the Romans did not contribute to the development of the sciences or general intellectual cultivation, but they made immense or solid contributions in the area of technology. They introduced the Julian calendar, built roads and aqueducts, formed a public medical service and formed the Roman legal code to regulate their organizations (Mason, 1979, p.61).

As a matter of fact, even the primitive man of the Stone Age period, who invented several tools in order to handle many of his existential problems, possessed a sound system of technology. This is because there is evidence that, even at that time, different skills,

techniques and instruments were in existence. Technology, therefore, should be seen as a systematic way of doing things or the creation of tools to handle or tackle existential problems.

In the history of Europe, the period between 455 AD and the reign of Pope Sylvester II is often referred to as the Dark Ages because it was a period of barrenness associated with no intellectual prowess in the sciences and philosophy. But this was still the period of several technical innovations which impacted positively on the lives of the people and improved their standard of living. By way of examples, there was a change from wearing toga to trousers, the use of butter instead of olive oil, making of barrels and tubs; the cultivation of the following was introduced; rye, oats, spelt, and hops; there was the use of stirrup for riding horses, the heavy wheeled plough was introduced and this eventually led to three-field system upon which agriculture depended in the Middle Ages. (Mason, p.103).

Fusion of Science and Technology

Although technology and science originated differently and followed their own separate evolutionary developments, they eventually became fused in the 18th century, about two hundred years after science had been accepted as the paradigm of rationality. This period is the era of modern technology: it is believed to have started with the steam engine and the first automatic regulator devices. It should be noted, howbeit, that people like Gilbert and Bacon had advocated a system which will combine the craft and scholarly traditions in the 16th century and averred that it will bring about enormous wealth. They appear to have been vindicated, since the modern technological era has brought tremendous wealth and comfort to mankind. Modern technology itself received a boost or got revolutionalised when the principle of replaceable parts was introduced. This brought about specialisation in production, assembly lines and services that made it possible for several household appliances, cars, television sets, radios, etc. to be available to a very large percentage of the populace. These far-reaching technological inventions and innovations were made possible because technology was now based on established scientific principles. In other words, modern technology is a function of the scientific culture, extensive research, and innovative technological education (See Tomovic 1982, p. 53). This being the case, it follows that any society that makes an effective use of the combination of scientific culture, research and technological education will achieve the same results. To be sure, this is the explanation for the success of the Asian tigers – the Japanese are outstanding in high quality industrial products as well as making solid contributions in the natural sciences, (Crease *et al.,* 1991, pp 161-2). The Indians have proved so outstanding that it is extremely difficult to overlook them in world politics, Singapore has invented the most efficient pubic sector in the world, Malaysia (which started palm production with palm nuts originally collected from Nigeria) is now the world leader in palm products. The same goes for the accomplishments of North Korea, South Korea, Israel, and China that has been able to sustain the largest population in the world, be the third country to go into space, turn an arid zone into an area of high productivity and be the world leader in biogas energy. It is also this same principle which made Cuba develop the most efficient health-care system in the world (Nwaorgu, 2004, p. 122; Adesina, 2003, p. 8).

Modern science contributes to modern technology in two ways. The first is that modern technology is founded on the assumptions of modern science. This leads to precision and accuracy and removes rule of the thumb. The technologist works within known principles and defined concepts which make it easy for his activities to be guided. Secondly, scientific theories may create new insights into the nature of things thereby making men realize that certain things could be applied in some ways. A new theory can also lead to the awareness of some previously unknown properties or features of known substances. It was Albert Einstein's postulation of the special theory of relativity in 1905 which led to the insight, among other things, that energy is matter and matter is energy. On the basis of the above, he established the formula that $E = mc^2$, (where E is energy, while m is mass and c is the speed of light). From this, it was realised that even the smallest piece of matter has an enormous amount of energy. It was this that led to the conception and eventual building of nuclear power stations (Coleman 1983, pp 63-4). It has been noted that about 30% of the GNP of the U.S.A. depends on the various applications of quantum mechanics (Atkins, 2003, p.202). Most of the time, as a matter of fact, researches in the pure sciences may not appear to possess any economic value, but some of them may eventually turn out to constitute the bedrock of the economy. (Wark, 1968, pp. 60-8). To be sure, the enormous resources being expended on cosmological research at present cannot be for the perceived benefits. (Singh, 2005; and Rees, 2000).

Science and Cultural Development

It has been argued above that science is a cultural process which attained its highest development in Europe. This is so even though every part of the world had developed one form of technology or the other. Science, per se, is the attempt to appraise human experience with the intellect. This will imply a critical evaluation of all our belief systems. When this happens, the scientific methodology will become the benchmark with which to evaluate other human activities. By adopting the scientific attitude Europe, and by extension, North America, sped ahead of other human societies. Since every human society is capable of doing science, what is required to be at par with Europe and North America, and perhaps overtake them is the adopting of the scientific culture. That this is not insurmountable has been established by the accomplishments of the numerous Asian countries.

Although science does not deal with absolute truths, which means that every scientific theory or even law is held tentatively, and so can be abandoned, altered or modified, or improved upon, it still remains the truth that science is not based on the rule of thumb and by its very nature, remains the most reliable approach of having insight into the nature of reality. This is because science is based on solid inductive procedures such as epistemic probability, causality and analogical inferences. For this reason, it is plausible to say that science deals with the laws of nature. This entails that it is through science that we acquire our most reliable knowledge of reality.

The above makes it imperative that the principles of science should be acculturated into our general cultural values. When we integrate science into our cultural system and accept its methodology as the hallmark of rationality, then every other human activity such as religion, the political system, the legal

system, and general world outlook would be evaluated by this methodology. Of course, this was what happened in Europe. One major benefit which will follow almost immediately will be the abandonment of magical thinking. This will make people subject their views to real analysis and verification. This happened in Europe and the direct consequences were freeing the human intellect to conceptualise and form abstractions. For example, any claim that cannot be verified on the basis of scientific methodology cannot be accepted as evidence in a court of law. By way of instance, the trial of witches and wizards was jettisoned (Capra 1984, p. 41).

RECOMMENDATIONS

It is a well considered view that the teaching of history of science and philosophy of science should be introduced in our secondary schools and continued in a more detailed manner in our tertiary institutions. The essence is to acquaint pupils and students with the prevailing circumstances under which most scientific hypothesis were postulated. It is hoped that this approach will familiarise them with these theories, thereby making them appear less contrived. From interaction with students, it is realised that some of them do not appreciate that science goes beyond notations and formulae. This is attributable to the fact that most of these scientific theories are propounded under circumstances different from our own which make it an uphill task for our students to see the cultural undertones. Acquaintance with the prevailing circumstances will not only increase awareness, but is also likely increase self-confidence and originality.

In the same vein, the teaching of logic should be introduced in the secondary schools and continued in the tertiary institutions. The reason being that science revels in logic, and secondly improving human rationality creates a fertile ground for the culture of science that is being advocated. Also, brilliant students should be encouraged to undertake the study of the pure sciences, with assurance of subsequent employment and good remuneration.

CONCLUSION

The central theme of this paper is that imbibing the scientific spirit by the people is a desideratum to move the country forward. Science has been presented as the evaluation of the human experience with the human intellect. Therefore, copying models or systems developed in other places, without first of all, ascertaining that they will fit properly into our society is an unscientific attitude and must not be encouraged. What is required most by our society is not technology or democracy or any other thing, but a situation that appreciates, improves or enhances, and encourages human rationality. When this happens, it will not be difficult to determine the things that we actually need, and also determine the means of realising them.

NOTE

[1]Paper is considered the greatest of all inventions for two reasons (i) it is the only invention truly by one man, (ii) the enormous role paper plays in every aspect of our lives.
For example, farming is older than agricultural science which is rooted in the understanding of the natural sciences. The concept of the natural sciences as they are understood today is, in fact, younger than farming.

[2]Paper is considered the greatest of all inventions for two reasons (i) it is the only invention truly by one man, (ii) the enormous role paper plays in every aspect of our lives.

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