CREATIVITY AND INNOVATION IN VOCATIONAL TECHNICAL EDUCATION: KEY TO THE 21ST CENTURY TRANSFORMATION OF THE GLOBAL ECONOMY IN NIGERIA

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Abstract

Vocational and Technical Education (VTE) system play a crucial role in the social and economic development of a nation. Owing to their dynamic nature, they are continuously subject to the forces driving change in the schools, industry and society. Often shaped by the needs of the changing economy and local community, the challenges and opportunities are unique, Law, (1984). The issue today is not so much about the value and importance of VTE but how to ensure its relevance, responsiveness, quality and values in an increasingly global economy. Lack of technological innovation has jeopardized creativity, entrepreneurial spirit and transformation of the global economy, thereby deteriorating the country’s economy exponentially. Nigerians import everything except excreta while we are languishing in poverty with low level standard of living. Many graduates of vocational technical institutions are jobless dependant because they lack creative and innovative skills. Nigerians must wake up from slumber to safeguard our future and wealth by adopting the Malaysian and Singapore experiences (Chiang, 1998).

The National Policy on Education (FRN, 2004) recommended the establishment of more National Technical Teachers’ Colleges for the production of manpower for the country (Biodun and Awoni, 1997). The Federal Government implemented this recommendation by establishing National Colleges of Education
The fact is that Polytechnics, Monotechnics and Colleges of Education (Technical) have common goals among which is training skilled technicians, technologists and other skilled personnel who shall be both enterprising and self-reliant. But to what extent do these Colleges of Education (Technical) produced qualified and well trained personnel?

Do the graduates have innovation to make new discovery? Do they (graduates) make any difference in the society? Are we progressing or retrogressing in the technological world? It may be difficult for any nation to develop without the contribution of creativity and innovation amongst the technical oriented graduates. Back in the days of colonial era, there were directives given by the colonial masters to enhance vocational/technical education.

However, this initiative collapsed because they failed to establish industries to absorb graduates from vocational schools (Fafunwa and Aisiku, 1982). Ever since, the Nigerian educational system has remained mainly academic and literary, producing graduates without functional skills (Wodi and Dokubo, 2011; Joseph 2013). The greatest challenges of VTE today is remaining true to its mission in staying focused in the area of vocational and technical skills, (Metzer, 2001). The real test of success of VTE are the employability of the graduates, personal development, opportunities for further education and carrier development, public acceptability and image. Unfortunately, the effectiveness and responsiveness of a VTE system would be measured by its impact on the social and economic development of the nation. This paper therefore seeks to explore platform that will initiate creativity and innovation in our school curriculum and enhance effective performances of the teachers to change the situation of the country from being dependent nation to a donor in technological creativity, innovation and development as the key to the 21st century transformation of the global economy in Nigeria.

Each VTE system is unique in its history and development. In the case of Singapore, VTE has evolved in response to the various phases of economic development since independence in 1965. As the economy was restructured and moved from labour-intensive to capital-intensive and then knowledge-intensive, ‘the VTE system responded to ensure that the workforce has the relevant knowledge, skills and values. The educational and training systems were reviewed, upgraded and remodeled to stay relevant and responsive to the needs of school leavers, industry and community. In particular, the experience of Singapore has shown how the Institute of Technical Education (ITE) has successfully transformed into a world-class post-secondary educational institution focusing on vocational technical education. Staying focused in its mission and vision, it has created a unique brand of an ITE College Education that is widely recognised locally and internationally for its relevance, quality and value in a global economy.
Creativity as a Prerequisite to Innovation

The term creativity and innovation are often used to mean the same thing, but each has a unique connotation.

Creativity

Creativity is “the ability to bring something new into existence”. This definition emphasizes the “ability”, and not the “activity”, of bringing new things into existence. A person may therefore conceive of something new and envision how it will be useful, but does not take the necessary action to make it a reality. Creativity is characterized by to perceive the world in new ways, to find hidden patterns, make connections between seemingly unrelated phenomena and to generate solutions (Ezemno and Offor, 2012). It is a phenomenon whereby something new is created which has some kind of subjective value, turning new and imaginative idea into reality. It is also the tendency to generate or recognize ideas, alternatives or possibilities that may be useful, ability to transcend traditional ideas, rules, patterns, relationships or the like, to bring new products.

The Creative Process

Clearly, action by itself has no meaning, it is of little value to simply “do things” without having inspiration and direction. Entrepreneurs need ideas to pursue, and ideas seldom materialize accidentally. Isaac Newton, may have been hit on the head by a falling apple, but he discovered gravity through a lifetime of scientific investigation. Ideas usually evolve through a creative process whereby imaginative people germinate idea, nurture them, and develop them successfully. A model of the creative process is shown in figure 1 below.

Various labels have been applied to stages in the creative process, but most social scientists agree on five stages that label: an idea germination; preparation, incubation; illumination, and verification. In each stage, a creative individual behaves differently to move idea from the seed stage of germination to verification, and as we will see, behaviour varies greatly among individuals and their ideas.
Figure 1: The Creative Process

Idea Germination

The germination stage is a seeding process. It is not like planting as a farmer does to grow corn, but more like the natural seeding that occurs when pollinated flower seeds, scattered by the wind, find fertile ground to take root. Exactly how an idea is germinated is a mystery; it is not something that can be examined under a microscope. However, most creative ideas can be traced to an individual’s interest in or curiosity about a specific problem or area of study.

For example, Alexander Graham Bell had been fascinated with the physics of sound since childhood. He was influenced to study hearing systems by his mother, who had a serious hearing problem. As a young adult, Bell taught at a school for the deaf and hearing-impaired, and he set up a laboratory for testing new hearing devices. Many of these devices were awkward mechanical “horns” that amplified sound waves. Bell realized the possibilities of altering sound waves in various types of materials such as steel wire during the 1870s, and he experimented for several years with magnetic devices in an effort to produce a hearing aid. In 1875, his lab assistant, Thomas A. Watson, accidentally clamped a magnetized steel reed too tightly to a magnet, and when he plucked at it, the reed came loose with a “twang” that echoed, sending a signal along a wire to Bell’s magnet receiver. Bell heard the twang and recognized that an electrical signal had replicated the vibration caused by Watson’s steel reed. At that instant, the harmonic hearing aid became a feasible idea, but
exactly when Bell conceived of a harmonic telegraph (telephone) is unknown. It was several years before he turned his attention to commercial communications.

Bell’s “idea” for a hearing aid was evidently seeded years before he invented the telephone, and it evolved through his interest in helping others. He had already spent years studying the physics of sound and experimenting with sound-transmitting materials so that his mind was “fertile” and open to the opportunities for harmonic telegraphy. For most entrepreneurs, ideas begin with interest in a subject or curiosity about finding a solution to a particular problem. More recently, Nolan Bushnell founded Atari and the video game industry by trying to create a way to use microelectronic circuitry to convert home television sets into interactive media.

**Preparation:** Once a seed of curiosity has taken form as a focused idea, creative people embark on a conscious search for answers. If it is a problem they are trying to solve—such as Bell’s determination to help those with impaired hearing—then they begin an intellectual journey, seeking information about the problem and how others have tried to resolve it. If it is an idea for a new product or service, the business equivalent is market research. Inventors will setup laboratory experiments, designers will begin engineering new product ideas, and marketers will study consumer buying habits. Any individual with an idea will consequently think about it, concentrating his or her energies on rational extensions of the idea and how it might become a reality. In rare instances, the preparation stage will produce results, more often, conscious deliberation will only overload the mind, but the effort is important in order to gather information and knowledge vital to an eventual solution.

**Incubation:** Individuals sometimes concentrate intensely on an idea, but, more often, they simply allow ideas time to grow without intentional effort. We all have heard about the brilliant, sudden “flashes” of genius—or more precisely, we have developed fables about them—but few great ideas come from thunderbolts of insight. Most evolve in the minds of creative people while they go about other activities. The idea, once seeded and given substance through preparation, is put on a hack burner; the subconscious mind is allowed time to assimilate information.

In Alexander Graham Bell’s example, research on harmonic sound transmission occupied a small percentage of his time during a two-decade period. Perhaps the incubation period for telephone, could be expressed as a three-decade, on-again-off-again fascination, with human hearing problems. Art Fry, the 3M engineer who invented Post-it Notes, first thought of semi-sticky paper six years earlier when, as a church choir director, he wanted to have page markers for hymn books that would neither damage the books nor slip out easily. He worked on the idea during his spare time at 3M without success, forgot about it for nearly a year, then tried making
a new adhesive for the paper, once again forgot about the project for some time, and eventually envisioned a pad of small hymn notes with tear-off edges impregnated with a nonpermanent gum.

Incubation is a stage of “mulling it over” while the subconscious intellect assumes control of the creative process. This is a crucial aspect of creativity because when we consciously focus on a problem we behave rationally to attempt to find systematic resolutions. When we rely on subconscious processes, our minds are untrammeled the limitations of human logic. The subconscious mind is allowed to wander and to pursue fantasies, and it is therefore open to unusual information and knowledge that we cannot assimilate in a conscious state. This subconscious process has been called the art of synectics, a word coined by W.J.J. Gordon in 1961. Synectics, derived from Greek, means a joining together of different and often unrelated ideas. Therefore, when a person has consciously worked to resolve a problem without success, allowing it to incubate in the subconscious will often lead to a resolution.

Illumination: The fourth stage, illumination, occurs when the idea resurfaces as a realistic creation. There will be a moment in time when the individual can say, “Oh, I see!” Bell heard the twang of the steel reed, Fleming watched his penicillin attack infectious bacteria under a microscope, and Art Fry envisioned his gum-lined note pads in use. The fable of the thunderbolt is captured in this moment of illumination—even though the often long and frustrating years of preparation and incubation have been forgotten. Illumination may be triggered by an opportune incident, as Bell discovered harmonic telegraphy in the accidental twang created by Watson. But there is little doubt that Bell would have had his moment of illumination, triggered perhaps by another incident or simply manifested through hard work. The point, of course, is that he was prepared and the idea was incubated. Bell was ready for an opportune incident and able to recognize its importance when it occurred.

The important point is that most creative people go through many cycles of preparation and incubation, searching for that incident as a catalyst to give their idea full meaning. When a cycle of creative behavior does not result in a catalytic event, the cycle is repeated until the idea blossoms or dies. This stage is critical for entrepreneurs because ideas, by themselves, have little meaning. Reaching the illumination stage separates daydreamers and tinkers from creative people who find a way to transmute value.

Verification: An idea once illuminated in the mind of an individual still has little meaning until verified as realistic and useful. Bell understood what the twanging steel reed meant, yet he still had years of work ahead to translate this knowledge into a commercial telephone system.
Entrepreneurial effort is essential to translate an illuminated idea into a verified, realistic, and useful application. **Verification** is the development stage of refining knowledge into application. This is often tedious and requires perseverance by an individual committed to finding a way to “harvest”, the practical results of his or her creation. During this stage, many ideas fall by the wayside as they prove to be impossible or to have little value. More-often, a good idea has already been developed, or the aspiring entrepreneur finds that competitors already exist. Inventors quite often come to this harsh conclusion when they seek to patent their products only to discover similar inventions registered. Therefore, we need creative and innovative people in VTE who are inventors, creators and innovators to transform the global economy of Nigeria like those of yesterdays.

**What then brings creativity?**

**Innovation:** Innovation is the process of doing new things. This distinction is important. Ideas have little value until they are converted into new products, services or processes. Innovation means a deep thought that brings new ideas, renewing, changing or generate new plans or theories. It also means a vision which tends to creating new prototypes, either from extinct products or present ones, this serves as a platform in which new ideas are being created. Throughout history, great innovations have periodically occurred to thrust humankind forwarded with new technologies, new industries or new economic systems (Holt, 1992). Technical and vocational students need to be groomed on how to fathom new ideas basically for improvement in their field of study. Innovation, therefore is the transformation of creative ideas into useful applications, but creativity is a prerequisite to innovation.

**Innovation and Entrepreneurship**

If creativity is the seed that inspires entrepreneurship, innovation is the process of entrepreneurship. This was Schumpeter’s conclusion when he wrote about the economic foundations of free enterprise and entrepreneurship. Drucker agrees and elaborates: “innovation . . . is the means by which the entrepreneur either creates new wealth-producing resources or endows existing resources with enhanced potential for creating wealth.”

Earlier, we defined innovation as the process of doing new things. It is important to recognize that innovation implies action, not just conceiving new ideas. When people have passed through the illumination and verification stages of creativity, they may have become inventors, but they are not yet innovators. The difference between invention and innovation is shown in Figure 2.
Inventors are not limited to those who create new products. They include those who identify new technological processes, new forms of plant life, and new designs. Each of these incidentally, can lead to new patents. Inventors usually are stereotyped as people who deal with “things,” such as new products, but most inventions have dealt with new processes or new technical knowledge, our examples of Bell’s harmonic sound transmission and Edison’s electric power system illustrate the point, and many new products (and entire industries) were founded on their ideas.

Nevertheless, for an idea to have value, it must be proven useful or be marketable, and to achieve either status, the idea must be developed. Innovation is the development process, as shown in Figure 3. It is the translation of an idea into an application. It requires persistence in analytically working out the details of product
design or service, to develop marketing, obtain finances, and plan operations. If the entrepreneur is going to manufacture a product, the process includes obtaining materials and technical manufacturing capabilities, staffing operations, and establishing an organization.

**Using Left-Brain Skills to Harvest Right-Brain Ideas**

Creativity was partially explained as a non rational process of incubating ideas, allowing the subconscious mind to wander and to pursue fantasies. More precisely, half the subconscious mind is working to wander intuitively through non rational territory. Substantial research has shown that the human brain has two distinct hemispheres. One, *the right hemisphere*, is the creative side where spatial relationships are developed, intuition prevails, and nonverbal imagining influences one’s behavior. The other, *the left hemisphere*, is the analytical side where abstract thoughts and concepts may be formulated, but only through logical and rational processes.

Exhibit 1 lists attributes of both hemispheres together with types of managerial activities often associated with skills in each area. Psychologists, suggest that most people tend to have a dominant orientation, either to the left side (prone to rational, analytic behavior) or to the right side (prone to creative, intuitive behavior). Indeed,

<table>
<thead>
<tr>
<th>Exhibit 2</th>
<th>Left-Brain, Right-Brain Attributes</th>
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<tbody>
<tr>
<td>Left Hemisphere</td>
<td>Right Hemisphere</td>
</tr>
<tr>
<td>Conscious—Aware and focused on specific problem</td>
<td>Unconscious—Unaware and unfocused on specific issues</td>
</tr>
<tr>
<td>Rational—Conscious modeling of issues; linearity</td>
<td>Nonrational—Spacial imagining without direction</td>
</tr>
<tr>
<td>Analytical—Use of knowledge in discrete applications to evaluate issues</td>
<td>Intuitive—Total experiences and emotions allowed to influence one’s ideas</td>
</tr>
<tr>
<td>Logical—Deductive reasoning to establish relationships</td>
<td>Synthesizing—Ilogical reasoning and fantasizing to create analogies</td>
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Many cultures encourage skills and value that bias human development toward one of these hemispheres. Japan, for example, has been singled out as more left-brain orientated than the United States. The implication is that Japanese
youngsters are taught to sharpen their analytical skills and subsequently are rewarded for their technical expertise, but they are not necessarily encouraged to become adept at creative, abstract thinking. In contrast, American youngsters are rewarded for independent thought and abstract, non rational synthesizing of information. There is, however, no consensus that people can, or should, be taught left- or right-brain skills.

From a technical perspective, the right-brain skills are crucial for the vision necessary to be creative, but innovation does not occur until left-brain rationalization takes place integrating predispositions from both hemispheres is the critical behavior needed to be a successful innovator, to use left-brain rationality to “harvest” right-brain creativity. Unfortunately, many individuals are only gifted at one or the other; they may be logical and practical, and in the process, be efficient managers, but without some degree of inspired fantasizing, they may be paralyzed by their own analytical behavior. On the other hand, the “inspired tinkerer” may bask in the purity of artistic oblivion without the necessary ability to convert dreams into reality. This dichotomous behavior has been called Janusian thinking. (Janus was a mythological god with two faces looking simultaneously into the future and the past.) To be innovative, the technical person must resolve this dilemma.

**Technological Innovation**

The battle between rational, left-brain behavior, and creative, right-brain behavior, is a common problem for technological innovation. Because innovation is often explained in technical terms — tangible products or processes that result from technological development — there has been a pre-occupation with rational, analytical in

![Diagram](https://via.placeholder.com/150)

**Figure 4: People in Technological Innovation**

**Innovation Models.** A general model of technological innovation is shown in Figure 3. However, a number of industrial studies reveal that for a technological innovation to succeed, there are three important people involved and seven important conditions
to satisfy. The combination of these people and conditions satisfies the need for creativity and implementation. The three key people are the creative source, the champion, and the sponsor. Their roles are identified in Figure 4 and explained as follows:

**Creative Source:** The inventor or originator of the idea that led to the knowledge or vision of something new; the artist of creative endeavor.

**Champion:** The technical person or manager who pursues the idea, planning its application, acquiring resources, and establishing its markets through persistence, planning, organizing, and leadership.

**Sponsor:** The person or organization that makes possible the champion’s activities and the inventor’s dreams through support, including finances, contacts, and advice.

The creative source is an individual; organizations do not create ideas or incubate fantasies. The champion is also an individual—perhaps the creative source, or an individual who joins with the inventor, or a corporate manager who has the insight to help pursue a creative idea. The sponsor may be an investor (such as a venture capitalist, or an organization, such as 3M, where corporate resources are allocated to innovative projects and their champions.

The seven conditions required for success in technological innovation is related partially to the success of the three key people involve and partially to the environment in which innovation takes place. Although these conditions were derived from corporate studies in research and development, they apply equally to new technical ventures, and they include the following:

1. An outstanding person in an executive leadership position to support strategic decisions that encourage creativity and innovation development.
2. An operational leader to carry out the essential tasks of converting knowledge into a commercial application.
3. A clear need for the application by sufficient potential consumers to warrant the commitment of resources to the innovation.
4. The realization of the product, process, or service as a useful innovation providing value to society.
5. Good cooperation among the crucial players and among diversified functions in an organization, all of whom, together, must bring the idea to fruition.
6. Availability of resources and the supporting technology to succeed in the endeavour.
7. Cooperation and support from external sources who can influence the success of an innovation, including government agencies, investors, vendors, suppliers, and creditors.

These seven conditions and the three major players are illustrated in an extraordinary new development in quantum mechanics. Research is being conducted at Spectra Diode Laboratories in California to develop the manufacturing process and applications for a semiconductor laser no larger than a child’s thumb. This tiny laser is a thousand times more powerful than anything commercially available in semiconductors. The “creative genius” of quantum physics (the science that made possible innovations in atomic energy and semiconductor electronics) was Albert Einstein. A number of “champions” in several industries have taken Einstein’s creative genius to practical applications.

Beyond the world of high-tech innovation, technical individuals take up the creative challenge of new ideas daily. Many of those innovations we take for granted as we enter the 2000s, but half of all our existing technological applications did not exist two decades ago. This applies equally to products, such as microcomputers; process technologies, such as synthetic fabrics; and services, such as bank credit cards.

In each instance of innovation, there has been a technical champion who persisted in developing a creative idea into a marketable application. In each instance, the technical innovator has been able to recognize change, envision the opportunities, and harvest right-brain inspiration through left-brain hard work.

**VTE Strategies and Transformation of the Global Economic Development**


**Motivation:** Motivation from government or private establishments brings about new ideas to create brands and modify productivity. Nigeria government has failed to motivate students, thereby creating loopholes for idleness and all criminal acts. There are supposed to be quarterly exhibitions or competitions with prizes to be won for new innovations, ideas and new products by technical and vocational students which will encourage and attract many to join the train and intrigue them to think of getting acquainted with new ideas from grassroots to the state and federal level.
Modification: Technical courses in our institutions should embrace modification practices in order to boost the morale of the students, this will allow them to work on platforms, study and modify to suit different purposes. Example is a burglar alarm circuit in electronics course which is one of the simplest circuits, tutors should endeavour to compel the students to first design the circuit, study and change some components therein with another species to produce same output. With these procedures, students will be able to ascertain some modification which will enlighten them more on creating new prototypes.

Access to Material: This point also brings creativity in the sense that anyone who needs to work on new ideas must locate the materials needed with ease. Materials are very essential to production or creation in which the idea could be futile if there are no good materials available, in other words, the materials should be of good quality irrespective of the function or price. An innovator could be despondent if he keeps trying an experiment with series of procedures and the components or materials needed are not available or the ones on ground are sub-standard.

Research Institutes: There must be a place to horn technological innovations and research development. Institutions should clamor for a research institute for developing new ideas so that each will be motivated to work tirelessly in bringing new things.

Standard Laboratories: A well equipped laboratory will entails sophisticated machines, mechatronics or pneumatics gadgets for adequate practical works. Most schools have no laboratory for practical, some Universities has segregated practical to Polytechnics while Colleges of Education exclude themselves from practical oriented programs.

Funds: Government and school authorities should create funds for technological development programs like research work in schools and colleges. Funding is very paramount in creativity because we have versatile and intelligent youths with strong vision but no capital to aid the vision come to reality. Private and non-governmental bodies should also stand up for this because most of their products could take new brand and new look if they can fund new innovation and development for the youths.

Reality Shows: Many private organizations had succeeded in taming our youths for diverse shows in showcasing their talents and promoting their products, dancing, singing, choreography to mention a few have been in vogue in the country thereby making them exposed socially but neglecting the most important aspect of their future which is education and technological development. Creativity should be encouraged through reality shows, media display, exhibition and teaching on how to create new
things from the local raw materials which will increase the agitation for our local brands instead of spending more on importation. Schools also can organize reality shows to showcase their creativity to boost the economy growth of the country.

**Conclusion**

Gang (2004) stated that there is need for reformation of educational system, he emphasized on re-design of syllabuses and curricula approach. A comprehensive reform towards technical and vocational education and a deliberate attempt to uplift the program is the only panacea to technology retrogression in the country (Ojimba 2012). Educational curriculum should portray creativity for the country to develop technologically and alleviate poverty in the country.

**Recommendations**

Technical and Vocational Curriculum must includes hand-made works, starting from modification which enables the students to create new products. Appraisals of the lecturers in technical and vocational schools should include “what they produce in a session” which will allow the students to liaise with their lectures and brings new ideas. Standard and well equipped laboratories must be built in each technical driven institution. Students of the Colleges of Education (Technical) should be compelled to go for internship programs in the industries based on their field of study, instead of teaching practices in order for them to learn more and have a tangible idea of what to do and how to make new things.

Technical and vocational students’ final project must be construction not research or abstract write-up which must be strictly monitored by their supervisors. Schools should make provision for affordable materials and components for practical out of the departmental fee paid by the students to aid the less buoyant one. Workshop and trainings should be organized for students and lecturers while the lecturers should be sent out for trainings for them to be conversant with the new development in their field because technology advances on daily basis.

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