RE-ENGINEERING TECHNOLOGY EDUCATION FOR EMPLOYMENT AND SELF PRODUCTIVITY

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Abstract

In order for technology education as an educational field to remove the seemingly poorly communicating mission it has been accused of a thorough re-engineering is needed as a panacea. It therefore appears appropriate to consider a new theoretical foundation for the field. upon which a new curriculum will be anchored which serve will as a medium to equip the students with necessary knowledge, skills and abilities to function effectively in a global economy The paper therefore provided a philosophical framework for technology education that hold true to some pedagogical approaches that are at the heart of the success of Technology Education (contextual learning, problem solving instruction and project-based instruction) while at the same time embracing new philosophies of learning and thinking (constructivist engineering design and system thinking). The paper among others recommends that the Federal Government through the Federal Ministry of Education should have the strong political will to make sure that there is serious re-engineering of technology Education. It also recommends increase industry participation in the training of science and Technology students. Thirdly entrepreneurship courses in science and technology should be place much more premium as this will enable students acquire entrepreneurial skills that will help them engage in technology driven businesses venture which will help to solve the problem of unemployment.

According to Dhiman (2007) education is defined as the process of imparting to an individual certain information and knowledge which society deems necessary. Technology Education is the acquisition of practical and applied skills as well as basic scientific knowledge. It is the type of education that prepares individual as a productive member of the society (Umoru, 2000). It is not a misnomer to say that the key factor of all economic development comes out of the mind of man therefore; human resources development has a multiplier effect on utilization of all other resources. The basic problem of the under developed countries is not the poverty of natural resources but the under-development of its human resources. In today's industrialized society a broad based system for education and training is more essential than even natural resources. It is therefore, expedient to say here that Engineering Technology Education is clearly the most important contribution to the economic viability of any nation.

Engineering Technology Education plays an important role in developing the technical manpower required for industrial, commercial and business sectors for its sustainable growth. In the last two decades the world is significantly propelled by technological advances in information systems, materials and services. The contribution and role of the engineering profession to this progress have been substantial. In this context many have observed that the Engineering Technology education to day does not adequately prepare graduates for engineering practices thereby breeding unproductively and unemployment among teeming graduates (Hill, 2006).

The technological dominance of the United States has largely been possible because of its educational system which has supplied an abundance of Engineers besides business strategies managers, skilled technicians and skilled workers (Bhaskaran, 1996). Indian has formally recognized the importance of higher education and science and technology for natural development and committed itself to the development of science and technology manpower. Over the past fifty years, the country has provided full policy support and substantial public funds to create one of the worlds largest system of higher Education, a system, which includes some international, recognized institutes in the country to provide leadership role in higher education in engineering and technology (Becker, 2002). In Canada, continuous technological changes put pressure on engineering faculty to inject more and more technical content into their engineering curricula so as to produce graduates that are not only broadly educated and knowledgeable about the environment in which they live and work but also, sensitive to the economic, social, political, cultural and ethical dimensions of their work.

This pragmatic approach has been lacking in the Nigerian educational system thereby leading to situation whereby thousands of graduates are unemployed. This view was equally supported by Wani and Sharma (2000) who opined that the situation has been aggravated by education system itself which molds students for job/wage employment than for self employment. They further maintained that in the technical institutions, the technical abilities of students are developed, but little has been done to give exposure to the students about application of these abilities in launching entrepreneurial venture. This is inspite of the fact that entrepreneurial development gateways have already been established in technical institutions. This lacuna can be removed, if institutions start to requisite course relating to the entrepreneurship motivation, training to build up technical and managerial competence so as to face the challenges and uncertainties in the field of entrepreneurial venture. In Nigeria education system, little or no efforts have been geared towards the direction. It is as a result of the recognition of the fact that this paper attempt to address the situation.

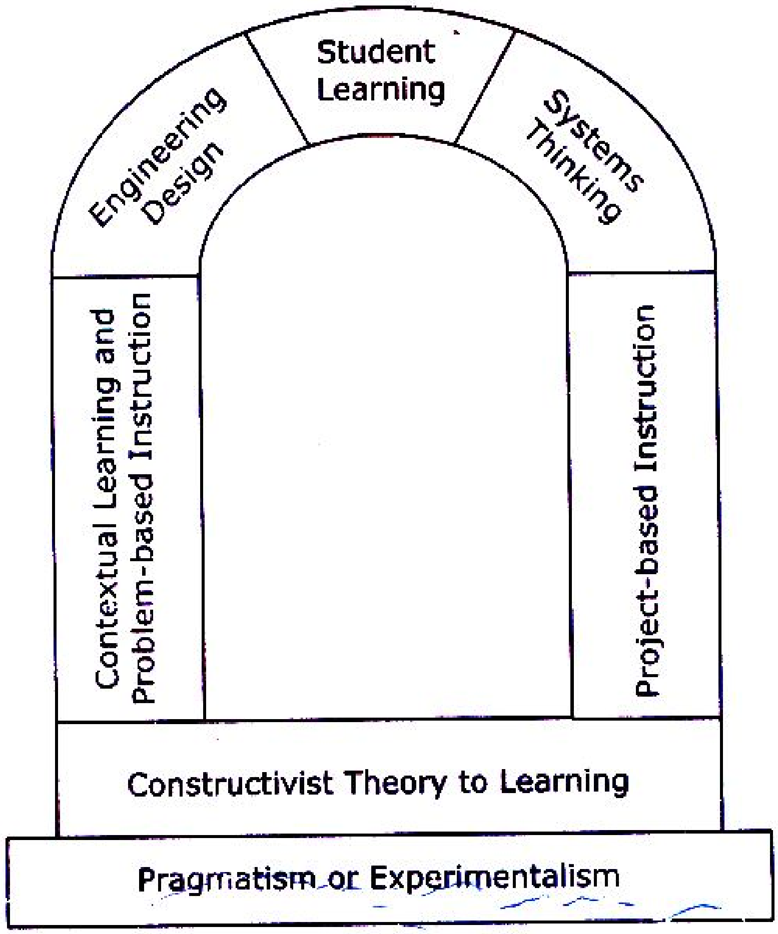
Theoretical Framework to Guide the Re-Engineering of Technology Education

According to Todd and Nadia (2009), a proper theoretical framework needs to be established so that the much needed re-engineering of technical education can be carried out. The teachings of Technology Education to all students will not only foster technological literacy, it will also address the needs of a work force seeking to compete in a global economy thereby, nipping at the bud stage the problem of unemployment.

Early in the 1990s, in the midst of the name change from industrial arts to Technology Education, the Journal of Technology Education (JTE) published a special theme issue dedicated to examine the state of technology Education from different theoretical perspective (Herschbach, 1992). Herschbach (1992) explains that although curriculum development is not an exert science, there are five basic curriculum patterns generally recognized by curriculum theorists. He identified the five patterns as academic rationalist (separate subjects), technical utilitarian (competences), intellectual processes, personal relevance and social reconstruction. Today, with the field of technology education on the verge of a new shift in focus, it is appropriate to consider a new theoretical perspective for technology education based upon the needs of today's learners and upon new knowledge of teaching and learning obtained through recent research.

The Archway of Meaningful Learning: **A proposed theoretical Framework.** The graphic in figure I below illustrates an archway to meaningful learning in technology education. The archway begins with a constructivist approach to learning through a pragmatist or experimental over-arching philosophy as theoretical foundation which all the other learning theories and approaches of learning rest upon.

Becker (2002) opined that contextual learning/problem based instruction and project-based instruction create columns of support for engineering design and system thinking to provide meaningful learning through a real world context. Both engineering design and systems thinking become the "drivers" of the learning experience. System thinking is above project-based instruction because system thinking is required for solving open-ended and ill-structured problems that society faces today and such problems are prevalent in engineering design projects. At the top of this archway of meaningful learning is student learning, forming the keystone of the arch, at the heart of why need to teach from a constructivist approach. Students learning are supported by all other "building blocks".



Source: (Todd & Nadia, 2009

Fig. 1: Archway to Meaningful Learning in Technology Education

Pragmatism or Experimentalism: The conceptual joint together of the proposed philosophy of Technology Education is founded on the ideas supported by the works of Woodward (1894), Dawey (1916) and Warner, Gray, Gekbracht and Phillips (1947), each of whom proposed that technology education is for all learners. That is, they believed that Technology Education should equip the learner with necessary knowledge, skills, and abilities in the context of technology and to live, function and work in today's technological society. They embrace a pragmatist view also known as experimentalism.

Pragmatism supports the notion that knowledge is gained through problem solving; it places great emphasis on critical thinking and reasoning and it seeks to solve the world's problem with an open mind (Scott and Sarkees-Wircenski, 2001). Technology Education supports engineering design as a vehicle for fostering technological literacy while simultaneously developing the skills needed to work in a global economy. According to Michael (2006), developing technological literacy goes far beyond producing vocational skills and making students "technologically savvy" as well as focuses on understanding how technology has changed our world and how we live in it. He added that Technology Education should prepare young people to cope in a rapidly changing technological world, enable them to think and intervene creatively to improve that world, develop skills required to participate responsibly in homes, schools and community life, help them become discriminatory consumers and users of products and help them become autonomous, creative problem solvers.

Scott and Sarkees-Wircenski (2001) stressed that technology education with a focus on engineering/design is beneficial to students who want to become Attorneys, Physicians, Accountants, and Business managers. One very important component of each of these occupations is that people working within them, function in an environment comprised of ill-structured problem. Educators agree that problem-solving skills are critical for a successful person in today's world, however, it is important to note that ill-structured problem solving helps to better prepare students, to cope with real world problems (Johassen, 1977). Well structured problems are constrained and usually have one correct answer, while ill-structure problems are not constrained and have multiple possible solution trajectors and final solutions (Jonassen, 1997). According to Brandsford (1994), Technology Education based on engineering design, design engineers to develop excellent systematic approach to ill-structured problems.

A Constructive Approach to Engineering Design and Systems Thinking: Jacobson and Wilensky (2006) suggested that young learners can handle complex systems even at the middle school level. They suggested using a constructivist approach to learning. Jacobson and Wilensky wrote: "A central tenet of the constructivist or constructivist learning approach is that a learner is actively constructing new understanding, rather than passively receiving and absolving facts". They believed that this method of learning can increase students understanding of complex system as well as be more interesting, engaging and motivating for students when assigned authentic problems studied within cooperative learning environment. Blekstein and Wilensky (2004) conducted research in this area of system thinking with results suggesting pedagogical approaches that involve students generating questions, hypotheses and theories about a particular phenomenon. Students then develop experiments or create conceptual models using multi-agent or qualitative modeling software to confirm or refute their theories. Jacobson and Wilensky (2006) recommended a constructivist approach to teaching system thinking within a team or group-learning environment. Wankat (2002) and Becker (2002) agreed that a constructivist approach is critical to improving the teaching of engineering and technology education. Reflecting on the work in *How People Learn* (Bransford, Brown and Cocking, 2002), Wankat believes that the student, not the teacher, must be on the 'driver' seat of learning. Bransford, Brown and Cocking (2000) described four crucial perspective of learning environments:

- Learner centered: Teachers must pay close attention to the knowledge, skills attitudes that learners bring into the classroom.
- Knowledge centered: Attention must be given to what is taught (information, subject matter), why it is taught (understanding), and what competence or mastering.
- Assessment centered: Formative assessment – ongoing assessments designed to make students thinking visible to both teachers and students are essential.
- Community centered: A community centered approach require the development of norms for the classroom and school as well as connections to the outside world, that support core learning values.

Becker (2002) explained that a constructivist approach is inherent in the standards for technological literacy and that a shift from behaviorisms to constructivism is critical to educate and assess today's student so that they are prepared for today's global economy. Wankat (2002) warned against the *content tyrant*, a phenomenon that takes place when the teacher wants to cover certain content by controlling the teaching and learning that takes place in the classroom, something that has plagued engineering education for years.

Crawford (2002) suggested that there are five key strategies for actively engaging students in a constructivist approach to teaching. These five strategies are:

- Relating – learning in the context of one's life experience or pre-existing knowledge.
- Experiencing – learning by doing or through exploration; discovery, and invention.

- Applying – learning by putting the concept to use.
- Cooperating – learning in the context of sharing, responding and communicating with others.
- Transferring – Using knowledge in a new context or novel situation, one that has not been covered in class.

Contextual Learning

While the constructivist teaching strategies suggested by Crawford (2001) Wankat(2001) Becker (2002) and Bransford et al (2000) emphasize the critical importance of content for effective teaching and learning, contextual learning, as described by Borko and Putnam (2000) is situated, distributed and authentic. They suggested that all learning should take place or be situated in a specific physical and social context to acquire knowledge that is intimately associated with these setting. Borko and Putnam also advocated that for transfer of learning to occur, students must be provided with multiple similar experiences allowing an abstract mental model to form. Hanso, (2006) proposed contextual learning as a key strength for technology and engineering education programs, allowing for transfer of knowledge from core subjects. Additionally, they suggested that contextual learning is a key concept in helping technology education aligns with *No Child Left Behind* and providing learning opportunities for students to become prepared to work in a global economy. Teaching engineering design must be done within a context that is authentic.

Newmann and Wehlage (1993) suggested that authentic activities have the following dimensions:

- Involve higher order thinking where students manipulate information and ideas.
- Require a depth of knowledge that students apply what they know and are connected to the world on such a way that they take on personal meaning.
- Require substantial communication among students.
- Support achievement of all through communication and high expectations of everyone contributing to the success of the group.

Hutchinson (2002) suggested that problem – based learning is an additional field of inquiry worthy of consideration. Problem-based learning presents students with a problem situation and then they are asked to determine what is happening. Pierce and Jones (2000) suggested that the world is of contextual learning theory and problem-based instruction can converge to produce highly conceptualized learning focused on questions and problems relating to real-world issues.

Engineering Design and Systems Thinking: The Ideal Context for Problem and Project Based Instruction.

Wicklein (2006) and Daugherty (2005) endorsed engineering design as an ideal platform for addressing the standards for technological literacy (ITEA 2000/2002), while also creating an instructional model that attracts and motivates students from all academic level. Today's workforce requires job skills that move beyond excelling in the basic core subjects (Grasso and Martinelli, 2002). A national employer survey identified desired job skill needed in today's workforce. Today's jobs require a portfolio of skill in addition to academic and technical skills. These include communication skills, analytical skills, problem-solving and creative thinking, inter-personnel skills, the ability to negotiate and influence and self-management (The National Centre on the Educational Quality of the workforce, 1995). Dearing and Daugherty (2004) conducted a study to identify the core engineering related concepts that also support a standard-based technology education curriculum by surveying 123 professionals in technology education, technology teacher education, and engineering education. The top five ranked concepts were:

- Interpersonal Skills – Teamwork, group skills, attitude and work ethic.
- Ability to Communicate Ideas – Verbally, physically and visually.
- Ability to Work within constraints/Parameters.
- Experience in brain storming and generating data.
- Product design assessment – Does a design perform its intended function?

Hill (2006) suggested that technology education is an ideal program to team up with engineering education to help young people develop communication skills, ability to work in teams, skills in social interactions and good business ethics. Todd and Nadia (2009) suggested the use of systems thinking approach to engineering design to study technology – related social problems because this platform is an excellent way to foster technological literacy and promote the attitudes, thinking skills and job skills listed above.

What is Systems Thinking and Why is it Important for Technology Education?

Jacohson and Wilensky (2006) wrote:

> Complex system approaches, in conjunction with rapid advances in computational technologies, enable researchers to study aspects of the real world for which events and actions have multiple causes and consequences and where order and structure coexist at many different scales time, space and organization.

Kay and Foster (1991) added that System thinking is about synthesizing together all the relevant information we have about an object so that we have a sense of it as a whole. Mapping out the complex issues of a system by reducing the system down to its parts and studying the relationships within those various parts is a process that leads to a better understanding of the system.

Bar-Yam (2002) maintained further that the ability of technology to expand human performance through design is dependent upon the understanding of systems and not just the components that lie within that system.

If technology education is to be successful in implementing a new program with an engineering design focus, it must be able to articulate the idea that learning engineering design can generate a type of thinking that can be applied to many occupations. With the application of engineering design and systems thinking, students learn how to use critical thinking skills to solve complex problems that are necessary to live and function in the 21st century regardless of whether the student plans to work in a factory, on a farm, or in a court-room. Engineering design and systems thinking provides a systematic approach to solving man's problem which is a vital that can transcend all vocations.

Conclusion and Recommendation

There is no gainsaying the fact that over a passage of time, Technology Education as an educational field has been accused of poorly communicating a clear version. In view of this premise, it is appropriate at this juncture to consider a new theoretical foundation for the field. Moreover, as new demands arise for educational programs that will equip the next generation of workers who are trained to survive and thrive in a global economy, a new philosophical framework geared towards re-engineering of technology education is needed.

This paper therefore attempted to provide a philosophical framework for Technology Education that holds true to some pedagogical approaches that are at the heart of the success in the process of re-engineering Technology Education (contextual learning, problem-based instruction, and project-based instruction), while at the same time embracing new philosophies of learning and thinking (Constructivist, engineering design, and system thinking). If technology educators determine that their purpose is to help prepare students to live and work in the global society, then these educators should consider carefully defining a philosophical framework upon which to build a new curriculum in a bid to "Kick"- Start the re-engineering process. It is expedient to say here that technology educators should look at this paper critically as a foundation for re-engineering of Technology Education as it has much promise in preparing students to function in today's technological society.

In the light of the foregoing, the following recommendations were advanced:

- The federal government through the Federal Ministry of Education should have the strong political will to make sure that there is serious re-engineering of the Technology Education in educational system.
- Incentives should be provided to retain good students in sciences, and encourage them to take up research and innovative careers.
- A concerted and combined efforts should be made to make sure that there increase industry participation in the training of science and technology students.
- Entrepreneurship courses in science and technology education curriculum should be places much more premium. This will enable the students acquire entrepreneurial skills that will help them engage in technology driven- business ventures. This will help them to create employment and be productive.

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