

INTEGRATING EDUCATIONAL ERGONOMICS INTO STUDENTS LEARNING OF TECHNICAL DRAWING IN GOVERNMENT SCIENCE AND TECHNICAL COLLEGES IN EDO STATE

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Abstract

In the modern world, technical drawing students spend quality time exposed to drawing equipment, computer and other electronic devices. This often results to mental and physical stress and many chronic diseases such as obesity, musculoskeletal disorders and many other sedentary issues that they may not be aware. The need to minimize mental and physical stress experienced by students during technical drawing learning in Government science and technical colleges in Edo State necessitated this study. Therefore, this study examines the workstations or learning environments and how students interact in it. Educational ergonomics can create productive, safe and satisfying technical drawing environment for the students.

It is assumed that regular exercises after long drawing hours can counteract the possible effect of the stress but this is not the case. In order to have a safe and healthy work environment, educational authorities must ensure that learners work is adjusted to their needs and preferences as well.

This paper focuses on the importance of integrating educational ergonomics students learning in Technical Drawing and the need or ergonomic design consideration in the design of a Technical Drawing studio, laboratory or classroom and its influence on students' academic performance in Technical Drawing in Government Science and Technical Colleges in Edo State.

Introduction

In contemporary Nigeria society, there is a growing emerging need for technical college curricula to respond timely to global and national challenges. Notable among the challenges are the new information and communication technologies, development of creative abilities and analytical thinking, and employability that could be acquired in institutions such as technical colleges. Technical Colleges (TCs) are middle level educational institutions established with the aim to train and producing technicians for industry. It is an aspect of the general education responsible for implementing Technical and Vocational Education and Training programme at the middle level. Technical and Vocational Education and Training (TVET) has become an integral part of the total education programme and contribution towards the development of good citizens by developing their physical, social, civic, cultural and economic competencies (Odu, 2011).

The aims and objectives of Vocational and Technical Education and Training (TVET) as stated in the National Policy on Education (2013) by Federal Republic of Nigeria are to:

- Provide trained manpower in applied science and technology and commerce, particularly at sub-professional levels;
- Provide the technical knowledge and vocational skills necessary for agricultural industry, commerce and economic development;
- Provide people who can apply scientific knowledge to the improvement and solution of environmental problems and for the use and convenience of man;
- Give training and impart necessary skills leading to the provision of craftsmen, technicians and other skilled personnel who will be enterprising and self-reliant.
- To enable our young men and women to have an intelligent understanding of the increasing complexity of technology.

The fields of Science, Technology and Engineering have much to offer in the area of economic development and provision of modern conveniences to mankind. This is why Governments, institutions and managements emphasize the need for practically oriented technical education curriculum and the need also to provide effective teaching of technical subjects in Nigeria colleges (Nkweke 2013). Technical drawing is key among the technical subjects towards the realization of certain objectives.

Specifically, the general objectives of the Technical Drawing as a subject are to:

- a. Provide an understanding of the theoretical and applied concepts relating to the use of ICT to facilitate visual communication of ideas in the construction and production industries;
- b. Provide an introduction to modern Drawing Studio Practice;
- c. Lay the foundation for technological development and further studies in Building and Engineering;
- d. Stimulate, develop and enhance entrepreneurship skills in the diverse areas of Drawing Studio Practice (Federal Ministry of Education, 2016).

The content of the curriculum was enriched with practical and computer applications. It is structured using the spiral approach. Competency-based learning, demonstration with practice, activity-oriented teaching and learning and work site experiences are among the teaching-learning strategies recommended for teaching and learning of the Technical Drawing content.

Technical drawing which is taught in secondary schools and Technical Colleges is an important aspect of technology education (Oke&Olakotan, 1994). Imagine architecture, civil engineering, or shipbuilding without the knowledge of technical drawing or drafting is the act and discipline of composing drawing that visually communicate how something functions or is constructed. It refers to a universal graphic language of lines used in the scientific world to cover mind concepts and ideas which are not limited to any particular national language which all and sundry can speak without correction (Elom, 2014).

It is essential for communicating ideas in industry and engineering. In order to make the drawing easier to understand, people use familiar symbols, perspectives, units of measurement, notation systems, visual style, and page layout. Together, such conventions constitute a visual language and help to ensure that the drawing is unambiguous and relatively easy to understand. Many of the symbols and principles of Technical Drawing are codified in an international standard called ISO 128. The need for precise communication in the preparation of a functional document distinguishes Technical Drawing from the expressive drawing of visual arts. It is therefore one major means of communication in the field of engineering. Artistic drawings are subjectively interpreted - their meaning are multiplied and determined. Technical drawings are understood to have one intended meaning.

Manual Technical Drawing was widespread before Computer Aided Design (CAD) systems were developed. Typically, a drawing board is used for it with a sliding straightedge known as the T-square. This allows the drawing of parallel lines and all kinds of angles and shapes. The T-square enables the drafting technician to use other drawing instruments such as the set square effectively. In recent years, Technical Drawing is mostly done using CAD systems and the whole process has been automated and improved. Using a CAD system, one can deliver precise Technical Drawings much faster in engineering design, fabrication of unit parts of goods requires precision measurements that is easily done with CAD.

Engineering can be a very broad term. It stems from the Latin “ingeniare”, meaning “to create”. Because this could apply to everything that humans create, it is given a narrower definition in the context of Technical Drawing. Engineering drawings generally deal with civil, electrical and mechanical engineering items, such as manufactured parts and equipment. They are usually created in accordance with standardized conventions for layout, nomenclature, interpretation, appearance, size among others. Its purpose is to accurately and unambiguously capture all the geometric features of a product or a component. The main goal of an engineering drawing is to convey all the required information that will allow a manufacturer to produce that component. Basically, Technical Drawing is the bedrock of Engineering Drawing which requires the provision of effective and adequate teaching and learning facilities with proper ergonomic design considerations in our technical colleges (Elom, 2014).

What is Ergonomics?

Ergonomics, as defined by the International Ergonomic Association (IEA) (2015) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance.

It is the process of designing or arranging workplaces, product and system so that they fit the people who use them. **Ergonomics is the science of making jobs, buildings and environments fit the workers or their users.** Chedi and Mustapha (2020) defined Ergonomics as the study of the interface between individual physiological environments. It focuses on outcomes such as reducing physical fatigue, ache and pains and health problems. It is aimed at engineering products, buildings and the environment to meet the comforts and health of the individual, human beings directly involved in its utilization. Ergonomics is concerned with 'fit' between people and their technological tools and the environment. It considers the users capabilities and limitations in ensuring that tasks, equipment, building, information and the environment suit the user. An ergonomic injury can affect an individual's productivity. When the principles of ergonomics are applied in the context of workplace safety, the concept of ergonomic safety is born. Ergonomics can help reduce cost by improving safety in buildings (international Ergonomics Association, 2015). Ergonomics safety ensures that the products, methods, and environment that worker uses are appropriate to fit the worker's job requirements and personal capabilities. Obi (2015) opined that the high level of safety risk exposure among employees in Nigeria is as a result of the unpopularity in the use of ergonomics design and impunity in Nigeria workplace environment.

Good knowledge of ergonomics helps in appropriate application and contributes significantly to the general well-being and safety of workers at the workplace (Oladeinde, 2015). Most people have heard of ergonomics and think it has something to do with seating or with the design of car controls and instruments. It applies to the design of anything that involves people's workspace, building, sport and leisure, health and safety.

The Ergonomics Society of Nigeria (ESN) defines it as a branch of science that aims to learn about human abilities and limitations, and then apply this learning to improve people's interaction with products, systems and environment. It aims to create safe, comfortable and productive

workspace by bringing human abilities and limitations into the design of a workplace, including the individual's body size, strength, skill, speed, sensory abilities and attitudes. The goal of ergonomics is to fit the task to the individual not the individual to the task.

The International Ergonomics Association (IEA) (2015) divides ergonomics into three broad dimensions: physical ergonomics, cognitive ergonomics and organizational ergonomics. Physical ergonomics is mainly concerned with the physiological interactions of people and **their activities**. Cognitive ergonomics deals with the mental (intellectual and psychological) aspects of the operator-activity relationship, such as perception, reasoning, memory, stimuli and psycho-motor responses. Organizational ergonomics focuses primarily on the structural issues of professional regulations. For the purpose of this work, educational ergonomics which is science of applying ergonomics to education, will be considering only the dimension of physical ergonomics in the learning environment of Technical Colleges in Edo State. Physical ergonomics for technical drawing studio or classroom consider the studio architectural design and the drawing facilities in the studio. They include lighting for vision, windows and doors for ventilation, arrangement of drawing tables and stools arrangement, the spacing between one drawing table and another. The arrangement of other facilities for teachers – student and student – student interaction such as projector slide, computer simulation gadgets, audio and visual aided facilities.

Historically, the practice of ergonomics safety principles can be possibly traced back in the early Egyptian, Greek, and Roman dynasties, where findings have shown that tools and other man made devices (e.g. pulleys, wheels) were created to minimize workload. Fast forward to the aftermath of the Industrial Revolution, people began developing factory machinery with some design principles closer to how we practice modern ergonomics.

In 1857, Wojciech Jastrzebowski, a Polish scholar, then coined the term 'ergonomics' – which comes from the Greek words *ergon* (work or labor) and *nomos* (natural laws) – in his publication. When World War II concluded, research on ergonomics and safety continued to expand as more and more technological advancements were introduced. Perhaps the most noteworthy development in modern ergonomics safety happened in the field of human-computer interaction, brought on by the explosion of computer usage in the workplace and, soon after, the home (Cao, 2019).

Ergonomic injuries clearly have a significant impact on both the individual and the institution as a whole. Eighty percent of people will experience back pain over the course of their lives. Ergonomics isn't just about pain; it's an issue that can also affect the bottom line. It can have a strong impact on any organization and there are benefits while applying it:

1. Reduced cost of production by decreasing injuries occurrence of the learners.
2. Improved productivity is the result of a better designed workplace which ensures good posture, less exertion and fewer motions of the learners.
3. Better quality because poor ergonomics leads to frustrated and fatigued learners who don't do their best at work.
4. If a learner does not experience fatigue and discomfort during his/her workday, this can result in a decrease of absenteeism, improved moral and increased learner involvement,
5. Better human performance is possible because of safe and health culture created in the organization.

Interdisciplinary Nature of Ergonomics

Ergonomics is a scientific area where multidisciplinary researches on technique, technology and environment on the human and with the interdisciplinary ergonomic approach, it is attempted to reconcile the relationships in the human-job system with the aim of humanizing work and the drawing process. It is a relatively new branch of science and relies on research carried out in many other older, established scientific areas, such as engineering, physiology and psychology.

To achieve best practices design ergonomists use the data and techniques of several disciplines:

- i. Anthropometry: body sizes, shapes, populations and variations
- ii. Biomechanics: muscles, levers, forces, strength
- iii. Environmental Physics: noise, light, heat, cold, radiation, vibration body systems
- iv. Applied Psychology: skill, learning, errors, differences
- v. Social Psychology: groups, communication, learning, behaviours
- vi. Industrial Design: mass production, repetitive work.
- vii. Kinesiology: body movements, physical activity, exercise, nutrition.
- viii. Physiology: functions and mechanisms of living organisms.
- ix. Mechanical Engineering: acoustics, automation, structural analysis.

Importance of Ergonomics Design in Traditional Technical Drawing Classroom

Globally, education has shifted from a traditional classroom setting to a technology driven setting. The technology driven classroom or studio has its footing in information and communication technology (ICT).

Ergonomics has helped students' efficiency in their classroom environment and when it comes to educating young minds, the results are enormous. Today's feature is the growing domination of automation and new production and technological conditions are set before the industry to transform drawing and production activities. The dynamic development of new technologies and the investment in new machines, devices, tools and drawing equipment sets the need to find solutions and create conditions that will ensure the humanization of work. There has always been an urge to organize and perform a job that will result in less fatigue and energy losses. Olabode and Bakare (2017) identified that the positioning and posture of computer users resulted in musculoskeletal disorders due to poor workstations design or an inappropriate work environment. Recent research has shown that lower back pain is the world's most common work disability affecting learners.

Students who work in a drawing environment tend to spend a lot of their day sitting in one spot. While sitting doesn't seem like it would cause injury, poorly designed chairs and improperly adjusted furniture can cause strain on the back, neck, and shoulders. In fact, poor quality task chairs are one of the top three ergonomic hazards we find in our classroom. Technical drawing is a task learners tackle regularly and a common cause of chronic pain if the workstation is not configured ergonomically.

Correctly adjusted armrests and drafting boards for Technical Drawing can go a long way in helping prevent injuries like carpal tunnel syndrome (CTS), musculoskeletal disorders (MSD) and repetitive strain injuries (RSI) (Arnold, 2019). Simply put, ergonomics looks at the interaction between people and the tools they use. More precisely, how learners and their tools interact. People who study ergonomics also look for ways to improve the design of the aforementioned tools to enhance their user experience.

A conscious visit to office environment will clearly that there are countless areas where ergonomics could be relevant. Everything from the chairs learners sit on, the desks they use or their posture when drawing or typing is a component of ergonomics. The ultimate goal of studying ergonomics is to find improvements in the tools learners use while working every single day. People are not productive when they are uncomfortable or in pain, but with the right tools, we can help them feel better at work and be more productive, happier, and healthier.

Ergonomic Design of the Classroom Environment

Some of the buildings and facilities may have been given ergonomic considerations in their design at the initial time, but over time due to over-use and lack of proper and regular maintenance, has been rendered unsafe for use. According to Asiabake in Uche (2015) observed that

the gross lack of regular maintenance of facilities and infrastructure in schools account for their present poor states. Recently the Universal Basic Education Commission (UBEC) stated that Nigeria is short of 43,456 classrooms, Nigeria Tribune 17 June, 2021. Most of the existing classrooms lack proper ergonomic design. Despite the knowledge of importance of the ergonomics in all sectors of the economy and institutions around the world, the level of ergonomics awareness in Nigeria is still low (Omoregie & Aguh, 2015).

Ergonomics concerns itself with the ever present ambition of humans to optimize their efforts in achieving their objectives. Part of that ambition is focused on optimally designing of the workplace, also by taking into account the capabilities and limitations of the learner. Thus, making the best use of space through optimum placement of equipment, integrating the human factor into workplace design, and effectively aligning the workplace into the surrounding environment are identified objectives of workplace design ergonomics. It is very important to select ergonomic chairs and desks for any type of education facility. Every chair should be easily adjustable, provide lumbar support and be appropriate to student needs. Depending on the style of learning, swivel and wheels could be useful to rearrange the room quickly. An ergonomic chair should consider the classroom layout, the learning style, and the duration of any activity students are completing. Once the learning goals of a classroom are set and learning styles are identified, a classroom can be designed ergonomically. Vibrant, flexible and fun learning spaces improve student learning outcomes. Throughout the year, a classroom's environment can affect student progress.

In stark contrast with the conventional classroom of previous generations, the modern learning environment is dynamic, welcoming, and practically structured for activity based learning. Featuring comfortable furnishings, bright colour palettes and modular spaces, today's classroom encourages collaboration, noise and movement. Together, the impact is significant. Ergonomic classrooms are proven to strengthen concentration, engagement, stimulation and overall performance. Classroom tables and chairs that are ergonomically designed offer so much more than just, support, posture and comfort. They are designed for flexibility, so that furniture can be easily maneuvered to suit the activity at hand, providing students and teachers with choices about how they learn or teach. Research has found that when human beings are faced with non-pleasing environments, a state of restlessness emerges, that is not conducive with learning. Ergonomic solutions today adapt to various body types and scenarios.

Classroom chairs are now designed to support the body's natural movement and varying postures or requirements. In fact, chairs such as the Jari Active Stool actually promote movement, in order to stimulate focus and concentration. Ergonomic classrooms enhance the physical look, feel and function of the classroom and its furnishings in order to maximize student motivation. When students – not to mention teachers, are spending more time in the classroom than they are in their own homes, a warm almost homelike atmosphere can be pivotal for overall morale and performance.

A student's learning experience is impacted by the classroom design around them. Features such as classroom lighting, the colour of the room, the air quality, the layout and the quality of the educational setting all affect students learning. In the 21st century, more and more learners and teachers are seeking a classroom layout that promotes collaboration.

Flexible Classroom Design

Flexible classroom design is something many schools strive for. They chose to replace the outdated and rigid row-column setups with various different layouts. This decision is motivated by the belief that allowing flexible movement and arrangement within the classroom encourages more collaboration and connectivity overall.

Some of the most common layouts featured in today's classrooms are the quad/cluster design, the horseshoe layout and distinct learning centers per table. A mixed floor plan is a good option for classes engaging in several different activities at the same time; this works especially well for young

children. It can also be useful for universities where different classes are held in the same room.

Classroom decoration is often overlooked, having colours on the walls, along with educational posters, Technical Drawing charts and models, will make them feel more at home. Kinesthetic learners will love to have props and toys that engage their problem-solving skills. Another 'decoration' could be the use of music in the classroom. It can create a whole new world for students and be used to stimulate their imaginations. Visual aids like projectors and smart whiteboards can also be implemented.

Designing an Ergonomic Technical Drawing Studio

Every institution is expected to establish a program that addresses the interactions among humans and the environment which is the learner and their workstation. A scientific discipline that is important in creating such program is ergonomics. It is basically the science of fitting the job to the worker and not the other way round.

Some institutions provide their learners with facilities for their work station which help them to prevent injuries. They focus on workstation design that has a big impact on their learners' health and well-being. Workstation design is complemented by understanding the symptoms of work, its related injuries and assessing their causes when analysing: lengthy periods of repetitive activities, awkward work positions and uncomfortable environment conditions, all contribute to a stressful learning environment

Designing an ergonomic workplace means taking account of the learners' feedback along with the above mentioned activities, before preparing and implementing a training program. This training will guide learners through the correct practices and/or activities that should be followed in order to mitigate the risk of injuries in a drawing studio. The implementation of the program includes detail on correct postures while sitting, arrangement of the workstation, adjustments and usage of the keyboard mouse, monitor position, lighting and associated ergonomics equipment.

One of the new pieces of ergonomic office equipment that is useful in a drawing studio is a "stand-up desk" that encourages you to stay active and productive throughout the day. Using this desk in a standing position will lead to an increase in calorie burn, enhanced focus and protection against any health-related issues linked to a sedentary lifestyle. Also, Sit-to-stand desks are becoming incredibly popular in modern office environments. These desks give learner the ability to seamlessly move from sitting to standing position without interrupting their work in any significant way. Experts recommend that learners spend at least ten minutes of every thirty minutes standing or walking. A sit to stand desk makes this easy. Other desks include the blue glass drafting table, oakwood top drafting table.

Ergonomic chairs are also a great solution to help learners feel great while working. When looking for ergonomic chairs, you should seek out chairs that provide adequate support for the lower back. The design of the chair should help the muscles in the back relax as students sit and work. Ergonomic chairs for this purpose include double back, mid back, smug desk drafting chairs. Features to consider include height and width, adjustability, foot rest, materials. Therefore, using the correct approach and ergonomic equipment while designing your workflow, will make for a comfortable working environment typical for a drawing studio.

Conclusion

Education is a human right and a force for sustainable development and the elevation of the human condition. This is the primary concern of education. Integrating ergonomics into physical teaching and learning facilities constitutes major determinants in the success of teaching and learning in any institution. In recent times, technology has become more complex, so ergonomics is undoubtedly destined to play an increasingly important role in technical education, production system, industrial design, planning and control and institutional health and safety. Ergonomics works for a comfortable, convenient, user acceptable and productive work environment. It is therefore very pertinent that priority be given to the provision of proper environment so that the key

factors in the educational process can effectively play their roles. Technology education objectives cannot be achieved in an unsafe environment with teaching and learning facilities that are detrimental to the health of their users. Effective teaching and learning can only take place in an environment whose facilities are ergonomically designed to fit its users in regards to their health and physical wellbeing. The teaching and learning facilities for technical drawing in the technical colleges in Edo State are not ergonomically conformed in terms of standards and specifications, and the institutions suffer from gross lack of facilities.

The increased rate of technological development in recent decades has created the need to consider ergonomics early in the design and development phase, and in a systematic manner. Because of the complexity of many new and modified systems, it is frequently impractical to make changes after they are actually produced. The cost of retrofitting frequently is exorbitant. Thus, the initial designs of systems and facilities must be as satisfactory as possible in terms of ergonomics consideration.

Recommendations

1. Provision of drawing equipment, instruments, materials and buildings that are ergonomically designed in Technical Colleges.
2. Provision of innovated workstations that include sit to stand desks, height adjustable desk, treadmill desks, pedal devices, cycle ergometers and Jari Active stools.
3. Provision of Drawing Studios well equipped with computers and application tools such as CorelDraw and Harvard graphics in addition to current text books and other instructional materials.
4. Well trained and motivated teachers who are computer literate should be employed to teach Technical Drawing.
5. There is need for Technical Colleges to establish well equipped blue print reproduction centres.
6. Postural flexibility and change should be provided. A learner should not be restricted to a workplace in such a way that he or she cannot change posture during the work.
7. Students should maintain good body posture and be knowledgeable about body strengths and limitations.

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