Int. j. adv. multidisc. res. stud. 2023; 3(1):192-199

Received: 17-11-2022
Accepted: 27-12-2022

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Workplace Ergonomic Principles and University Students Psycho-Production Skills in Welding Craft Practice in Ekiti State, Nigeria

Ogundola Ilesanmi Peter
Ekiti State University, Ado Ekiti, Nigeria

Corresponding Author: **Ogundola Ilesanmi Peter**

Abstract
This study was designed to determine the influence of work place ergonomic on psycho-production skills of university students in welding craft practice. The study adopted a pre-test, post-test, non-equivalent control group quasi-experimental research design which involved students in their intact classes assigned to both experimental and control groups. The population for the study was all thirty-five (35) 300 Level Technical education (mechanical option) students in two universities in Ekiti State, Nigeria. Two research questions and two null hypotheses, tested at.05 level of significance guided the study. The instruments used for data collection was the Arc Welding skills (AWPT) and the Arc Welding Interest Inventory (AWII).The AWPT and AWII instrument were subjected to face and content validation by three experts. The trial test for determining the coefficient of concordance of the AWPT instrument was determined by kendall coefficient of concordance. The value was found to be 0.78. Cronbach Alpha was used to determine the internal consistency of the AWII items. The reliability coefficient computed for the AWII was 0.75. Mean was used to answer the research questions, while ANCOVA was used to test the hypotheses. It was observed from the study that work place Ergonomic was effective in improving University students' acquisition of psycho-productive skills in welding craft practice. It was also observed that ergonomic principle instructional technique was more effective in stimulating students' interest than the conventional technique in Arc Welding work, it was thereafter recommended that seminars and workshop be organized for university lecturers teaching welding process to inculcate same into their practical classes among other recommendations.

Keywords: Ergonomic Principles, Technical Education, Arc Welding, University Students, Ekiti State

Introduction

Welding is a fabrication process used to join materials, usually metals or thermoplastics, together. During welding, the pieces to be joined are melted at the joining interface and usually a filler material is added to form a pool of molten material that solidifies to become a strong joint. Different types of welding processes include gas welding, resistance welding, Energy beam welding, solid state welding and arc welding.

Arc welding is a welding process that is used to join metal to metal by using electricity to create enough heat to melt metal, and the melted metals when the cool result in a binding of the metals.

It is one of several fusion processes for joining metals. By applying intense heat, metal at the joint between two parts is melted and caused to intermix directly, or more commonly, with an intermediate molten filler metal. Upon cooling and solidification, a metallurgical bond is created.

In such welding processes the power supply could be AC or DC, the electrode could be consumable or non-consumable and a filler material may or may not be added. The most common types of arc welding are Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), Gas Tungsten Arc Welding (GTAW), Plasma Arc Welding (PAW) and cutting, Submerged Arc Welding (SAW), Stud Wedding etc. Arc welding basic equipment include Welding Machine (Power Supply), Cable, Holder, Electrode, Cable, Hand Gloves, Goggles, Aprons, Chipping Hammers, Wire Brush advantages of arc welding over other types of welding includes the process gives high deposition rates, Welding speed is high, Wire consumption is low, The consumption of electrical energy is low, as a maximum of 97 % of heat energy can be utilized, Any length can be welded without any interruption, High-quality Welds are achieved with no fusion defects, no porosity and slag inclusions.

Arc Welding has varied Application such as in Industries Construction, Shipbuilding, Farm equipment, Lawn and Garden, Highway Equipment, Institutional Equipment, Railways Department, etc. It is a vital skill learnt by mechanical Technology option students of the technical education programme in universities in Ekiti state and the Nigeria at large.

The philosophy of the programme is derived from the national philosophy on Technical and Vocational Education which advocates acquisition of practical and theoretical skills and competences necessary for self-reliance and technological progress of the nation. The philosophy of the programme is also tied toward production of technical teachers who will impart practical skill on vocational and technical students at secondary school or technical college level. Students admitted into the progamme are made to spend four years when admitted with the senior secondary certificate (SSE certificate) or its equivalent qualification such as the National Technical Certificate (NTC) and Teacher Grade 11 ceritifcate (TC11) while direct entry students admitted with advance certificate (A' Level) or its equivalent are made to spend three years. Students admitted into technical education programme are given opportunity to specialize in their area of choice based on interest or entry qualification. Students can specialize in building, woodwork, electrical/electronic, automobile, metal work or mechanical technology. They therefore graduate with a B. Sc (Ed) or a B.ED degree at the end of their programme. Arc welding skill are taught to metal work or mechanical technology students at their third year of study.

The objectives of the technical education programme, (Inclusive of arc welding practice) at the university, according to Ekiti State University (2012) is to produce teachers who can occupy teaching and leadership positions in Secondary Schools, Technical Colleges, Colleges of Education, Universities and Training Programmes in Industrial Establishments among others. It is also to train graduates as well as entrepreneurs who can be self-employed in their trades with competence in the acquired skills

This goal can however be achieved only when the skill is appropriately and effectively taught to learners. Accordingly, Onanuga and Bada (2014) [18] opined that there will be adequate acquisition of relevant skills only if effective vocational training is given where the training jobs are carried out in the same way with the same operations, the same tools, the same machines and workshop facilities.

In line with the National University Commission (NUC) directive that stipulate separate workshops and facilities be provided for Technical Education Programmes, majority of the universities have separate workshops and facilities for each of the technical education programme i.e., wood work, building, automobile, electrical/electronic and metal workshops

Technical education metal workshops in universities in Ekiti State houses arrays of rolling, bending, cutting and welding machines. The workshops also house variety of hand tools such as cutting, measuring, holding, drilling, welding torches and automated machinery for constructing prototypes and final pieces. The workshops are equipped to deal with both large-and small-scale projects. The facilities are also open to all students, but as safety is paramount in the workshops, full supervision are provided by Technologists, Technical officers and workshop attendance. This is to allow students to work safely and independently using same Psycho-productive skills as required in the occupation or work.

Psycho productive skills which emphasizes more on the psychomotor domain of the bloom taxonomy are acquired abilities or manipulative skills required for performance in any given occupation. Accordingly, Osinem and Nwoje (2015) [10], view Psycho productive skills as manipulative or technical skills needed for performance in any given occupation which could be acquired through observation, training and learning. Osinem (2018) [19] further sees it as manipulative skills or motor skills which are required to perform certain activities such as the step-by-step activities involved in arc welding efficiently.

Psycho productive skills is concerned with development of muscular skills and coordination. It emphasizes motor skill, manipulation of materials or objects or an act which requires neuromuscular coordination (Knoll, 2004).This could be a performance task as simple as simple as arranging tools and materials for carrying out arc welding to a more complex task as performing submerge arc welding procedure. Thus, psycho productive skills involve manual dexterity required by arc welding students for effective and efficient manipulation of arc welding tools and equipment and the step-by-step procedure for using them to accomplish the operational skills in welded metals and machinery through the application of ergonomic principles

Ergonomics is an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely (LightGuide, 2021) [9]. In this same vein, Matt (2022) [14] stated that Ergonomics is a scientific discipline concerned with the understanding of interactions among humans and other elements of system and the profession that applies theory, principles, data and methods to design in order to optimize human wellbeing and overall system performance. Accordingly, Mark (2022) [13] identified three broad domains of ergonomics to include cognitive, organizational and physical ergonomics.

Cognitive ergonomics focuses on the ability of the mind to process information and interact with data. It lay much importance on the design and visibility of safety signs in workplaces. It is the field of study that emphases on how well the use of a product matches the cognitive capabilities of users It is concerned with intellectual processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans. (ErgoPlus 2022) [7]

Organizational ergonomics on the other hand is concerned with the overall process of increasing a company's yield, output or performance. This is done by emphasizing teamwork, smooth communication, job shifts, work satisfaction and cordial relation among company staff. It thus refers to the optimization of social technical system, such as the organizational structures, policies and processes. (Alison, 2018) [3]

Thus, it can be inferred to be the process of designing products and workplaces to accommodate the people who use them or the study of working conditions especially in the design of tools, equipment and furniture to help people work efficiently.

While the Organizational ergonomics is concerned with the overall performance of the workplace, the Physical ergonomic is all about the safety and comfort of the individual in the work place. It focuses on building better working place with jobs designed to match abilities of people resulting in better working experience. It is an approach or solution to deal with a number of work-related musculoskeletal disorders. Physical ergonomics are arguably the most important type of ergonomics, as most employers prioritize physical comfort when trying to accommodate their workers. (Harris 2000) [8], Physical

ergonomics focus on the ways in which people's bodies interact with the tools they use on a daily basis. Such tools may include welding machines, piller/ hand-held drilling and cutting machines etc. Physical ergonomics is very much focused on workplace ergonomics

Workplace ergonomics is the science of designing the workplace, keeping in mind the capabilities and limitations of the worker. (ErgoPlus, 2022) [7]. Brain and Spine (2018) also affirm that workplace ergonomics attempts to reduce strain, fatigue and injuries by improving product design and workspace arrangements.

These arrangements can be the properly positing of work tables, welding machines, and other welding related hand tools. Having an ergonomically correct workspace can result in less body strain, slouching, twisting and reaching, which can cause musculoskeletal problems and pain over time. Ill designed workshop can lead to fatigue, frustration and students' low psycho productive performance. It is also more likely to lead to painful and costly injury, lower productivity and poor product quality

The benefit of workplace ergonomics therefore can be said to include reduced risk of work-related injuries and illness, Higher productivity, Improved health, Improved mental insight, Better product quality, Decreased pain, Happy employee, Improved employee engagement, Better safety culture (Physiopedia, 2022) [20].This benefits can maximally be enjoined only if the principles of workplace ergonomics is holistically adopted.

Work in Neutral Postures

The best posture to work are those that keep the body in neutral positions. Neutral postures are that where the body is aligned and balanced while either sitting or standing, placing minimal stress on the body and keeping joints aligned.Neutral postures minimize the stress applied to muscles, tendons, nerves and bones and allows for maximum control and force production. (UnCaged, 2022). Working in an awkward (non-Neutral) posture is a major course of musculoskeletal Disorder (MSDs). The keeping of neck aligned, keeping elbows at sides and the keeping of wrists neutral are ways by which one can keep neutral posture. The Regents of the University of California (2022) [22] Thus when carrying wedding or measuring activities, any of the convenient neutral posture can be adopted.

Reduce Excessive Force and Vibration

Excessive force on one's joints is capable of creating the potential for fatigue and injury and thus the risk of an MSD. Many of the task and work carried out in the metal workshop require high force loads. Most wedded and fabricated products are heavy. Some high-capacity wedding machines are also very heavy.

There are numerous conditions that affect force, but the idea is to recognize when a job or task requires excessive force and then find ways to reduce that force. Alexis (2021) [2] advices worker to lighten the load, use mechanical-assist devices and carts, use larger muscle groups, and/or get assistance from a co-worker. Furthermore, adjustable height lift tables and workstations, powered equipment and ergonomic tools will reduce work effort and muscle exertions.

Vibration is another common problem that can have serious impact on students' health. Accordingly, Oliver (2018) [17] Assert that contacting vibrating tools may cause hand-arm vibration syndrome (HAVS). Frequent contact with hand-held motorize vibrating tools such as cutting and drilling machines can be reduced by the use of pillar machines to help prevent musculoskeletal disorders.

Work in the Power / Comfort Zone

The power, comfort or hand shake zone is the zone where interacting with objects has the least amount of effort spent. It has to do with working at the proper height for lifting close to the body, between mi-thigh and mid-chest height. This zone is where the arms and back can lift the most with the least amount of effort. The working from proper heights and reaches, reduces MSD risk factors and allows for more efficient and pain-free work. An efficient welder should be that who can perform his duties without needing to go through much effort before taking a new electrode, hammer or scriber.

Reduce Excessive Motions

The aim is to reduce number movement or motion made by the individual when working. This motion can be with one's finger, wrist, arms, neck or back in a day. Dan (2008) [4] opined that one of the simplest ways to reduce manual repetitions is to use power assisted tools whenever possible. This may include the use of electric screw driver of aim is to reduce hand motion during usage. Another approach according to Dan (2008) [4] is to change the layouts of equipment to eliminate unnecessary repetitive motions. Thus, an object being wed can be tilted to give room for it to be worked upon from different angle and direction without being moved.

Minimize Fatigue and Static Load

Working for long periods of time in a static position will cause one's body to fatigue. This is what is known as static load. Also holding an object or standing in the same position or continuous contact or rubbing between hard or sharp objects/surfaces and sensitive body tissue, such as soft tissue of the fingers, palms, thighs and feet can also result to static load. It creates fatigue and discomfort and can interfere with work. (UNCAGED, 2017) [23]. Holding tightly unto a writing pencil for a long period by a person can lead to cramp. This also apply to such tools as electrode holder, scriber, wedding rod, Chipping Hammers and Wire Brush which may not need to be hold tightly to for a long time. To this therefore, the using of clamps, jigs and fixtures eliminates the need to hold onto the part. Fatigue, according to Kusum (2018) can also be reduced by the intervals and the breaks between works

Minimize Pressure Points

The pressure point or contact stress refers to the point where the object is in contact with the consumer or workers body during usage.(UNCAGED, 2017) [23]. This contact, according to mark (2022) [13] creates localized pressure for a small area of the body, which can inhibit blood, nerve function, or movement of tendons and muscles. The prolong contact with the welder's palm of a pair of pliers during usage creates contact stress on the palm. The prolong hard squeezing of the tools caused a sharp pain at the point of contact. Adding a cushioned grip and or using contoured handle tools that fit the palm/hand reduces the pain associated to pressure point. tasks that require hand hammering during welding may also cause contact stress.

Again, the leaning of one's forearms against the hard edge of a work table can also create a pressure point. Dan (2008) [4] further exemplified that standing on a hard surface, like concrete makes one to experience pain on the feet and heels. In reducing or eliminating pressure points

Move, Exercise, and Stretch

The human body system is designed to move. To be healthy, the human body needs to be exercised and stretched. Depending upon the type of work one does, different exercises and movements on the job can be helpful. Alexis (2021) [2] asserts that Stretching reduces fatigue, improves muscular balance and posture and improves muscle coordination. If one is engaged in a physically demanding job such as welding and fabricating, it may be helpful to often do a few stretches or take a short walk after any strenuous activity. Working for long periods of time in a static position such as carrying out continues welding activity will cause one's body to fatigue (Kusum, 2018).

Maintain a Comfortable Environment

This principle has to do with both the immediate and overall work environment, inclusive of the individual work station and the work floor. Accordingly, Dan (2008) [4] opined that the overall work environment should be comfortable and allow users to have good lighting, fresh air, and enough space. Workers are to protect themselves from extreme temperatures and noise.

The need to inculcate in students' the workplace basic skills that will enable them to fit properly in the world of work, improve their productivity, interest and their physical and mental health, called for effective instructional techniques

Statement of the Problem

The problem of this study is that technical education students offering welding and fabrication in the university are not performing well in practical activities. There have been persistent reports of students performing below expectation in practical arc welding with majority of the students complaining of ill health (body pains and welders' flash) with numbers of students that enrolled into course gradually dwindling.

Purposes of the Study

Thus, the purpose of this study was to determine the influence of workplace ergonomic principles on psycho-production skills and interest of university students in welding craft practice in Ekiti state, Nigeria.

Research Questions

The following research questions were posed to guide this study:

1. What is the effect of psycho-productive skills performance on students' performance in welding craft practice?
2. What is the difference in the Mean interest scores of students taught welding craft practice using psycho-productive skills and those taught using conventional teaching method?

Hypotheses

The following Null hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in the Mean performance scores of students taught welding craft practice using Ergonomic principles in psycho-productive skills and those taught using the conventional teaching method.
2. There is no significant difference in the Mean interest scores of students taught welding craft practice using Ergonomic principles in psycho-productive skills and those taught using conventional teaching method

Methods

Design of the Study

A quasi-experimental design was used in this study. Specifically, the pre-test, post-test, non-equivalent control group design was adopted for the study. This design was considered suitable for the study because intact classes (non-randomized groups) were assigned to the two different groups in these studies i.e., ergonomic and control groups.

EG, O1 x O1 CG, O1 – O1

Where,

EG = experimental group
CG = control group
O1 = pre-test/post-test observation
X = Ergonomic principles instructional Technique treatments
– = use of the Conventional method

The independent variables consisted of conventional method and ergonomic peer tutoring technique, while the dependent variables were the posttest achievements.

Population & Sampling Technique

The population for the study comprises of all the 25 Technical Education students offering welding process course in the two state owned universities in Ekiti State. They include Ekiti state University and Bamidele Olumilua University of Education, Science and Technology. 300 level Auto/metal and Mechanical Technology students of the universities were adopted for the study. The reason being that it is at the level at which intensive welding practical are engaged in. All the students are used for the study. This is because they are manageable.

17 of the students were treated with ergonomic principle tutoring technique while the remaining 11 students were used as control group.

Research Instrument

The instrument for data collection for this study were the Arc Welding Psychomotor Test (AWPT) and the Arc Welding Interest Inventory (AWII) that were both developed by the researcher. The AWPT contained list of specific practical tasks which students are expected to carry out and to be rated by the examiner,

The Arc Welding interest inventory (AWII) was developed for the purpose of testing students' interest in arc welding works. The items were based on five-point Likert scale of Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (D) and Strongly Disagree (SD).

The ergonomic principle (EP) technique lesson plans were developed by the researcher also for the use of teaching the experimental group. Each of the lesson plans has at least five ergonomic principles built into each practical activity, which is, working in neutral postures, reducing excessive

force and vibration, working in power/comfort zones, reducing excessive motion etc.

Each of the EP lesson plan indicated among others, the lesson topic, specific objectives, entry behaviour, instructional materials and the instructional procedure. The instructional procedure showed details of the steps, content development, students and teachers' activities. The test items covered all the contents of the lesson plans developed to cover the major topics used for the study.

An ergonomic technique lesson plans was developed by the researcher also for the use of teaching experimental group, each of the lesson plans has at least five ergonomic principles built into each practical activity, which is, working in neutral postures, reducing excessive force and vibration, working in power/comfort zones, reducing excessive motion etc.

The lecture plan indicated among others, the lesson topic, specific objectives, entry behaviour, instructional materials and the instructional procedure. The instructional procedure showed details of the steps, content development, students` and Lecturer activities.

The ergonomic lesson plans were used by both the lecturer and technologist in charge of practical to teach the students in the affected institution. They are also the research assistants used for the experimental group while the control group was taught using the conventional method.

The AWPT contained list of specific practical tasks which students are expected to carry out and to be rated by the examiner. The test items were adapted from MWT 301 and ITE 351 past question papers in both universities used for the study. Face and content validation were conducted on the AWPT by three Vocational and Technical Education experts. The validation process entails checking the AWPT items against the topic and content of the lesson plans by ensuring that the test items reflected the course content. It also entails checking for typographical errors, arrangement and logical sequence, ascertaining the superficial quality of the instrument. Each of the validators was served with a copy of the AWPT instruments, Research questions, Hypotheses, syllabus and the Ergonomic lesson plan. The comments and suggestions by the validators were incorporated into the final draft of the Instrument.

The reliability of the AWPT was established after the corrections suggested by the experts were incorporated into the final draft of the Instrument by trial testing the AWPT on a group of nine (9) 300 Level metal Technology students in a university which was not part of the study institution. This was for the purpose of obtaining the coefficient of concordance of the Instrument. The MMPAT instrument was administered on the students and was rated simultaneously by three instructors. The established ratter reliability coefficient computed for the AWPT was 0.81. According to Jeevanand E.S. (2020), Kendal coefficient of concordance can be used for assessing agreement among different ratters on an issue or test, this is with a view to assess the consistency of the ratters arriving at a common or near common scores/agreement. Two Metal work/Mechanical Technology Lecturers were involved in the administration of the AWPT instrument in their respective institutions; there is need therefore, to assess the consistency or the coefficient of agreement among the different ratters.

As regard the Arc Welding Interest Inventory (AWII), a total of thirty-five statements about Arc Welding work was initially generated. These were also sent to Vocational Technical Education and Test and Measurement experts for face and content validation. The experts were specifically requested to examine the AWII items with respect to the extent to which the statements in the AWII assesses interest in the units of study. The suitability of the language used in the AWII with respect to the students' level of study and the extent of relationship between the AWII items and the student experiences in units of study. Following the face and content validation, the items were reviewed based on their comments, and thirty statements that made up of 15 positive and 15 negative items were finally chosen to constitute the AWII.

Cronbach Alpha was used to determine the internal consistency of the Arc Welding Interest Inventory items. The interest inventory was also administered on equivalent sample of 300 Level Auto/Metal or Mechanical Technology students in a university that wasn't part of the study. The reliability coefficient computed for the AWII was 0.79. This formula was considered appropriate for the same reason that composite scores of the students on the instrument were required. Also, the formula is applicable to items that are not dichotomously scored such as the AWII.

Experimental Procedure

One-week intensive training programme was organized for the Lecturers and Technologists who were involved in the study. The training exercise was based on the purpose of the study, the topics to be taught, the use of the lesson plans, the use of instrument and general conduct of the study. The conduct of the study took place during the normal practical periods. On the first day, before the commencement of practical class, The AWPT and AWII were administered as pre-test to both the experimental and control groups after which proper practical teaching begins. The experimental group was taught with ergonomic tutoring lesson plans by doing the following:

Experimental Procedure

The study was conducted in three phases, as described below:

The first phase was the pre-test stage. It was the phase in which the MMPAT and the MMII were administered on the subjects in the experimental and control groups. This phase of the study was done in the first week of the experiment. This exercise provided baseline data on the two dependent variables (achievement and interest).

The second phase featured the experimental group that was taught with the developed ergonomic principle technique lesson plans and the control group being taught with the conventional teaching method.

During the treatment, the workshop activities was organized in such a way that each of the students involved in the study were provided with a work project, complete arc welding equipment and accessories.

Thus, students were taught to work in neutral posture. Reasons for which was explained to them. Adjustable worktables and stools were provided for each of the student. Students were advised against carrying heavy loads. To this, motorized lift were provide in the laboratory.

At intervals of 30 minutes to 45 minutes students are encouraged to stretch their bodies or even encouraged to take a short walk. In order to minimize pressure points, students were encouraged to add a cushion material when

holding hard object for prolong time. Contoured hand tools were also provided for their use. The students were also encouraged to collaborate with one another, throughout the practical classes, the reasons for teaching them using the ergonomic principle approach was overly explained to the students in the experimental group.

On the other hand, the control group taught with the conventional laboratory teaching method was taught without modification to the laboratory. Each of the students were also provided with complete arc welding equipment ant tools. No reference was made of ergonomic principles while teaching the practical to the students. Both groups were taught safety in the workshop.

Both experimental and control groups were taught for 6 weeks. Practical classes are taught to student for two hours per week in both universities used for the study. To this therefore, each of the groups (experimental and control) were taught for a total of twelve periods.

The third phase was the post-test phase. The phase also lasted for one week. It witnesses the same AWPT being administered as post-test. The AWII instrument used for the pre-test was also administered on all the subjects in the two groups. This exercise provided post intervention data on each of the dependent variables (achievement and interest) after the treatments.

The data obtained from the students' scores were analyzed using mean for answering research questions and analysis of covariance (ANCOVA) to test the hypotheses of no significant difference

Research Question 1

What is the effect of psycho-productive skills performance on students' performance in welding craft practice?

Table 1: Mean of psycho-productive skill test scores of students taught with ergonomic principle and conventional techniques

Test	Teaching Techniques			
	Ergonomic principle		Conventional Method	
	N	Mean	N	Mean
Pre-test	17	24.47	11	25.36
Post-test	17	72.94	11	63.27
Mean gain score		48.47		37.91

The data presented in Table 1 indicate that the group taught arc welding with ergonomic principle technique had a mean score of 24.47 in the pretest and a mean score of 72.94 in the posttest making a posttest mean gain in the group taught with ergonomic principle technique to be 48.47. The group taught arc welding with the conventional technique had a mean score of 25.36 in the pretest and a posttest mean of 63.91 with a posttest mean gain of 37.91. Thus, both the conventional method and the ergonomic principle technique are effective in improving students' psychomotor achievement in arc welding work but the effect of ergonomic principle technique on students' psychomotor achievement is higher than the effect of the conventional technique.

Research Question 2

What is the difference in the Mean interest scores of students' taught Arc welding practice using psycho-productive skills and those taught using conventional teaching method?

Table 2: Mean of Interest Inventory Scores of students taught with ergonomic principle and conventional techniques

Test	Teaching Techniques			
	Ergonomic principle		Conventional Method	
	N	Mean	N	Mean
Pre-test	17	20.71	11	22.27
Post-test	17	76.82	11	58.36
Mean gain score		56.11		36.09

Table 2 shows that the group taught arc welding work with ergonomic principle technique had a mean interest score of 20.71 in the pretest and a mean interest score of 76.82 in the posttest making a posttest mean gain in the treatment group to be 56.11. The group taught arc welding work with conventional technique had a mean interest score of 22.27 in the pretest and a posttest mean of 58.36 with a posttest mean gain of 36.09. With these results, both the ergonomic principle technique and the conventional technique are effective in stimulating students' interest in arc welding work but the effect of ergonomic principle technique on students' interest in arc welding work is higher than the effect of the conventional technique.

Table 3: Summary of Analysis of Covariance (ANCOVA) for Test of Significance of Treatments on Students' psycho-productive skill Achievement in Arc Welding

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Corrected Model	628.440[a]	2	314.220	11.569	.000
Intercept	1840.671	1	1840.671	67.773	.000
Pretest	4.134	1	4.134	.152	.700
Treatment	594.859	1	594.859	21.902	.000
Error	678.989	25	27.160		
Total	135168.000	28			
Corrected Total	1307.429	27			

*Significant at sig of F< .05

The data presented in Table 3 shows F-calculated values for effects of treatment on students' psychomotor achievement in arc welding work. The F-calculated value for treatment is 21.90 with a significance of F at .00 which is less than .05. The null-hypothesis is therefore rejected at .05 level of significance. With this result, there is a significant difference between the effect of treatments (ergonomic principle and conventional techniques) on students' psych productive skill in arc welding work.

Table 4: Summary of Analysis of Covariance (ANCOVA) for Test of Significance of Treatments on Students' Interest in Arc Welding

Source of Variation	**Sum of Squares**	**DF**	**Mean Square**	**F**	**Sig of F**
Corrected Model	2276.503[a]	2	1138.251	17.077	.000
Intercept	2412.131	1	2412.131	36.189	.000
Pretest	.661	1	.661	.010	.921
Treatment	2270.017	1	2270.017	34.057	.000
Error	1666.355	25	66.654		
Total	139468.000	28			
Corrected Total	3942.857	27			

*Significant at sig of F< .05

Table 4 shows F-calculated for effects of treatment on students' interest in arc welding work. The F-calculated value for treatment is 34.06 with a significance of F at .00 which is less than .05. The null-hypothesis is therefore rejected at .05 level of significance. Hence, the null

hypothesis of no significant difference between the effect of treatments (ergonomic principle and conventional techniques) on students' interest in arc welding is hereby rejected at .05 level of significance.

Discussion of findings

The findings of the study as indicated on table 1 shows that students exposed to ergonomic principle in addition to laboratory method and those exposed to only conventional laboratory both had improvement in their psycho productive skills in arc welding work but the effect of ergonomic principle technique is higher than the effect of the conventional technique. At the same time, Analysis of covariance was employed to test the first hypothesis, Table 3, at the calculated F-value (21.90), significance of F (.00) and confidence level of .05, there was a significant difference between the effect of treatments on the students' psychomotor achievement. This implies that the ergonomic principle technique is more effective than the conventional technique in improving students' psycho productive skills in arc welding work.

The finding is similar to the finding of Aleksandar, Goran, Bozica, Lidija, Goran, Petar (2015) [1] titled The Role of Ergonomics in the Improvement of Quality of Education in which students exposed to ergonomic principles experience improvement in their process of education and training It is also in line with the study of Deolia, Dubey, Chandak, Patni, Padmawar & Sen (2018) [5] which evaluated the implementation of ergonomic principles in routine dentistry and observed that proper application of ergonomic principles and maintenance of a balanced posture could prevent the incidence of musculoskeletal disorders, and thus improvements in work productivity.

The effectiveness of the ergonomic principle technique when compared to the conventional laboratory technique may probably be due to the fact that students are made more comfortable, relaxed, and also work under less stress and fatigue conditions during practical activities. This assertion is corroborated by Mohammadreza, Babaei-Pouya, Mohsen, Maryam (2021) [16] in their study titled Ergonomics factors influencing school education during the COVID-19 pandemic: A literature review that environmental factors such as light, noise, ventilation, temperature, inner space condition, and furniture layout should be taken into account in the design of schools and that if the aforementioned factors are not based on ergonomic standards, the connection between teachers and students might be interrupted and learning performance might be degraded. It is also in line with the findings of Ikelusi (2013) [11] in her study titled Application of Ergonomics Principles on Student's Acquisition of Psycho Productive Skills in Maize Production in Senior Secondary Schools in Abuja where they also discovered that ergonomic principles as an instructional technique is more effective in enhancing students' performance and skill acquisition in post- planting and post-harvesting operations than the traditional method of instruction

The data presented in Table 2 provided answer to research question two. It was observed that both the ergonomic principle and conventional techniques are effective in improving students' interest in arc welding work but the effect of ergonomic principle technique on students' interest in arc welding work is higher. This finding indicates that ergonomic principle technique is more effective in stimulating students' interest in arc welding work than the traditional teaching method.

As regard the effect of Ergonomics principles on students' interest in arc welding work, it was observed that the ergonomic principle instructional technique had a higher effect on the students' interest than the traditional teaching method

This finding could be attributed to the same factors that lead to the increase in their psycho productive skill performance such as the provision of adjustable work tables, chairs and equipment that conforms with ergonomic principles and make learning fun, less stressful and fatigue free as against the traditional laboratory methods where all equipment and environment are presumably made for the average students. This finding is also in line with those of Mohammadreza *et al*. (2021) [16] who observed that factors like color, form, and layout of classrooms, lighting and ventilation, interior decoration, and educational equipment are effective in creating interest and motivation for students to learn. The findings also corroborated the study of Oviawei (2020) [12] who attributed her finding to the varieties of skills and techniques involved in using Ergonomics principles that aroused and sustained the interest of the students in the group taught with ergonomic principle than those in the control group.

References

1. Aleksandar Zunjic, Goran Papic, Bozica Bojovic, Lidija Matija, Goran Slavkovic, Petar Lukic. The Role of Ergonomics in the Improvement of Quality of Education. FME Transactions. 2015; 43(1). https://www.researchgate.net/publication/282792145_The_role_of_ergonomics_in_the_improvement_of_quality_of_education
2. Alexis Sheprak. The 10 Basic Principles of Ergonomics, 2021. Construction Pros.com https://www.forconstructionpros.com/rental/blog/21415547/jlg-industries-inc-the-10-basic-principles-of-ergonomics
3. Alison Heller-Ono. Ergonomic Principles Every Business Needs to Know for Office and Material Handling Success. Worksite International, Inc, 2018. https://www.worksiteinternational.com/hubfs/documents/ergonomic-principles-every-business-needs-to-know.pdf?t=1524267665581
4. Dan MacLeod. 10 Principles of Ergonomics, 2008. https://www.danmacleod.com/ErgoForYou/10_principles_of_ergonomics.htm
5. Deolia S, Dubey S, Chandak A, Patni T, Padmawar N, Sen S. Application of ergonomic postures during routine dental procedures in a private dental institute. Dentistry and Medical Research. 2018; 6(2).
6. Ekiti State University. Faculty of Education Handbook 2014-2017. Publication of the Faculty of Education, Ekiti State University, 2014.
7. ErgoPlus. Understanding the fundamental principles of Ergonomics, 2022. https://ergo-plus.com/fundamental-ergonomic-principles/
8. Harris. Survey of physical ergonomics issues associated with school childrens' use of laptop computers. International Journal of Industrial Ergonomics. 2000; 26(1).
9. LightGuide. What is Ergonomics? LightGuide

Incorporation, March 9, 2021. https://www.lightguidesys.com/resource-center/blog/what-is-ergonomics/
10. Osinem EC, Nwoje UC. Students industrial work experience in Nigeria: Concepts, principles and practice. Enugu: Cheston agency limited, 2015.
11. Ikelusi, Caroline Onyebuchi. Effect of Application of Ergonomic Principles in Psycho-Productive Skills Acquisition on Students in Maize Production in Senior Secondary Schools in Abuja. Unpublished Ph.D Thesis, University of Nigeria, Nsukka, 2013. http://www.unn.edu.ng/publications/files/PROJECT%20WORK%20_Ph.pdf
12. Jane Itohan Oviawei. Ergonomics Principles as Strategy for Promoting Students' Acquisition of Psycho-Productive Skills in Building Construction Trade in Technical Colleges in Edo State, Nigeria European Journal of Education Studies. 2020; 7(5). https://oapub.org/edu/index.php/ejes/article/view/3102
13. Mark Middlesworth. 8 Fundamental Ergonomic Principles for Better Work Performance, Ergo Plus, 2022. https://ergo-plus.com/fundamental-ergonomic-principles/
14. Matt Middlesworth. 101: The Definition, Domains, and Applications of Ergonomics. Ergo Plus, March 7, 2022. https://ergo-plus.com/ergonomics-definition-domains-applications/
15. Jeevanand ES. Kendall's Coefficient of Concordance, 2020. https://esjeevanand.uccollege.edu.in/wp-content/uploads/sites/114/2020/08/NON-PARAMTERIC-TEST-8.pdf
16. Mohammadreza Soltaninejad, Amin Babaei-Pouya, Mohsen Poursadeqiyan, Maryam Feiz Arefi. Ergonomics factors influencing school education during the COVID-19 pandemic: A literature review. Pubmed. 2021; 68(1):69-75. https://doi:10.3233/WOR-203355
17. Oliver Starr. Hand-arm Vibration Syndrome. Patient blog, November 27, 2018. https://patient.info/bones-joints-muscles/hand-arm-vibration-syndrome-leaflet
18. Onanuga PA, Bada AA. Creativity in tasks competence and psycho-productive skills performance in vegetable production among university Agriculture internship students. Journalof Science, Technology, Mathematics and Education. 2014; 10(3):145-159. https://jostmed.futminna.edu.ng/images/JOSTMED/Jostmed
19. Osinem EC. Managing agricultural education and training resources. Enugu: Cheston agency limited, 2018.
20. Physiopedia. Ergonomics. Physiopedia, October 27, 2022. https://www.physio-pedia.com/index.php?title=Ergonomics&oldid=319236
21. Shravani Deolia, Shivani Dubey, Aditi Chandak, Tanvi Patni, Noopur Padmawar, Sourav Sen. Application of Ergonomic Postures during Routine Dental Procedures in a Private Dental Institute Dentistry and medical Research. 2018; 6(2):41-45. Doi: https://doi: 10.4103/dmr.dmr_21_17
22. The Regents of the University of California. Maintain a Neutral Posture. University of califonia San Francisco, 2022. https://ehs.ucsf.edu/maintain-neutral-posture
23. Uncaged. Principles of Ergonomics in the Workplace. Uncaged Ergonomics, December 29, 2017. https://uncagedergonomics.com/blogs/default-blog/principles-of-ergonomics-in-the-workplace