

Employing Ergonomic Standards in designing Educational Laboratory for Hand weaving

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ABSTRACT

Occupational safety is considered one of the fundamentals of the success of educational system, especially in light of the remarkable development in the Industrial Revolution and the change it brought in study patterns and educational strategies that aimed in building the educational outcomes compatible with the changing labor market .

Proper, conscious, and organized planning of the components of the educational process has its positive impact on its success; this is because it takes into account the nature of the administrative conditions, the learner, and the educational environment in which they learn and interact with its components. The educational environment includes the educational laboratory, which represents an important element of the educational process in general, and the communication process, which creates interaction between "teacher and learner" in particular; this is done to preserve this element and make it effective, leading to the success of the process .

Keywords: Ergonomic Standards, Educational Laboratory, Hand weaving.

Introduction

The educational environment contributes in creating a continuous dynamic interaction between the human element, the educational environment and its components, and the machines used to achieve the desired educational, teaching, and production goals especially true since the field of arts learning aims to develop the learner's behavior, enhance his abilities, and provide him with the necessary experiences that help him adapt to the requirements of the labor market. Art is a mental and physical activity that sharpens the learner's creative abilities by organizing, arranging, and planning his thoughts and interests in a sound manner (Manar Jaber, 2019 AD, p. 14).

The art of hand-weaving is one of the arts that has been known since ancient ages and has been used to meet the necessary needs of the individual; it is also known as a heritage that carries the thought and culture of peoples. Today, this art has undergone many developments and diverse experimental stages that have added novelty to its form and philosophical content, and given it an expressive and aesthetic aspect with contemporary formative visions (Hebah Ramadan Al-Shoushani, 2012 AD, p. 32).

Since that every activity done by the learner requires the provision of an appropriate educational environment, including equipment, tools, furniture, and other supplies that facilitate the process of practicing this activity, the science of ergonomics inserts in all areas of life to improve the quality of production by creating a suitable and safe environment, taking into account health aspects and ensuring safety means to achieve maximum efficiency and quality in the system of technical and academic specifications and standards, as well as what relates to the work environment, especially in educational laboratories (Ahmed Wahid, 2010 AD, 10).

Ergonomic standards must be employed in the design of the educational laboratories, especially with regard to their components and supplies, such as lighting, temperature, furniture design, necessary machines, handlooms, tables, easels, storage cabinets, etc., and their compatibility with the learner's body and his movement within the educational laboratory. The suitability of educational laboratories for providing learners with educational information, experiences, and technical skills must be taken into account, as well as their lack of distractions, such as noise resulting from loud sounds inside or outside the educational laboratory (Aida Ahmed, 2016 AD, 8).

Studies that dealt with the ergonomic standards have varied, such as the study by (Rania Magdy, 2013 AD), which dealt with ergonomic specifications in educational facilities; the study by (Asma'a Mamdouh and Rasha Rashad, 2018 AD), which clarified the ergonomic considerations for housing design; the study by (Hind Abu Al-Shaar, 2008 AD), which aimed to clarify the generally adopted quality standards in higher education institutions (facilities, laboratory equipment, and all educational areas); the study by (Bassem Hassan Abdo, 2006 AD), which clarified ergonomics and performance effectiveness; the study by (Amal Bakkar, 2017 AD), which emphasized the success of ergonomic in achieving occupational safety for workers; the study by (Amer Abd El-Latif and Sta Thomas, 2012 AD), which clarified the impact of ergonomic on reducing costs and increasing productivity; and the study by

(Aida Ahmed, 2016 AD), which clarified the gap between the current situation and the desired one in applying the principles of ergonomics to the work environment. In addition to the study by (Abdul Nabi Abu Al-Majd, 2006 AD), which aimed to identify the methods of testing and evaluating models and products from an ergonomic perspective, and the study (Mohammed Abd El-Khaliq, 2019 AD), which revealed the educational requirements necessary to achieve a model university environment in light of the ergonomics approach "human engineering".

In order to achieve ergonomic standards in hand-weaving laboratories, must take into account to prevent bone and back diseases for users and those involved in the educational process. The nature of work in the weaving laboratory requires sitting for long periods inside the laboratory, and affected by the environmental factors such as lighting and ventilation, and the use of chairs, tables, devices and technical tools, which affects production and performance efficiency in the educational laboratories.

Since hand-woven textiles are one of the products that have been affected by ergonomics, which reflects the necessity of developing looms, tools, materials and work environments (study laboratories) with the aim of raising the level of quality, ease of use and saving time to achieve ergonomics standards, and benefit from its applications in a way that benefits society and individuals, and urge artists in various fields to contribute positively to serving society and solving its problems, and following public policies to maintain ergonomic standards, this is what prompted the researcher to study the possibility of employing ergonomic standards in designing an educational laboratory for hand-weaving to develop education and increase efficiency and meeting the needs of the labor market in the Kingdom of Saudi Arabia.

Problem of research:

Problem of research formulated in the main question:

What is the possibility of employing the ergonomic standards in designing an educational laboratory for hand-weaving that is compatible with the nature of the field and the quality of educational outcomes?

Many sub-questions emerged from the main question:

- 1- What is the extent of taking benefit from the ergonomic standards in designing an educational laboratory?
- 2- What are the requirements for designing an educational laboratory for hand-weaving?
- 3- What is the equipment that necessary to establish an educational laboratory for hand-weaving?

Research objectives:

- 1- Highlight the ergonomic concepts and terminology.
- 2- Detecting the mechanism of employing ergonomic standards and how to benefit from them in establishing an educational laboratory for hand-weaving.

3- Detecting the technical equipment necessary for an educational laboratory for teaching hand-weaving.

Research importance:

- 1- Enriching academic libraries with ergonomic standards and employing them in the educational laboratories.
- 2- Identifying the mechanism of employing the ergonomic standards in designing the educational laboratory.
- 3- Identifying the requirements that must be met in educational laboratories in art institutions and institutes.

Research terms:

-Ergonomic Standards:

- Ergonomics: It is a field of science related to understanding the interaction between humans and other components in their life system. Also, it considers a major craft that applies a lot of principles, scientific theories, data, and the appropriate methods in the design, as well as ergonomic standards that utilize principles, scientific theories, data, and the methods in the design. It is a science used to achieve the best balanced performance between the weaknesses and strengths between humans and machines (Ahmed Wahid, 2010 AD, 8).

- Design:

- The complete process of analyzing learners' needs and the educational goals, and building a system that meets those needs by developing a complete plan to use the elements of the learner's environment and the relations associated in it, so that it pushes him to respond to certain situations under specific conditions, in order to gain educational experiences and bring about desired changes in his behavior and performance to achieve the desired goals (Asma'a Mamdouh, Rasha Rashad, 2018 AD, 23).

-Educational laboratory:

- Physical, chemical, biological, organizational, social and cultural factors surrounding the worker, including the spaces of the spatial area that meet the needs and requirements of the target group, such that they affect their interaction and activity that they practice in the educational situation to accomplish artistic works, and in which the "human body mechanism" is taken into account, and this this laboratory includes "furniture, lighting, ventilation, and maintaining the temperature".

- Manual Art Weaving:

- It is an art known since ancient ages, and is formed through a structural relation between longitudinal and transverse threads (warp, weft), in agreed-upon structures and systems to form decorative woven surfaces. Its materials, tools, performance and techniques are varied to achieve more artistic values in addition to the color values. It has also progressed in its concept from craft to studio and carpet, then to the global

concept that made it one of the major arts. There are artistic expressions of three-dimensional weaving, optical illusion weaving, structural and abstract weaving for expression and formation with threads, and it has come to carry many artistic trends (Samar Al-Jaber, 2016 AD, 14).

Research hypotheses:

- 1- There are statistically significant differences among the mean of degrees in the pre- and post-application for employing the ergonomic standards in designing an educational laboratory for hand-weaving, in favor of the post-application.
- 2- There are statistically significant differences among the mean of degrees in the pre- and post-application for achieving safety in the educational laboratory for hand-weaving, in favor of the post-application.
- 3- There are statistically significant differences among the mean of degrees in the pre- and post-application for achieving comfort in the educational laboratory for hand-weaving, in favor of the post-application.
- 4- There are statistically significant differences among the mean of degrees in the pre- and post-application for achieving ease of use in the educational laboratory for hand-weaving, in favor of the post-application.
- 5- There are statistically significant differences among the mean of degrees in the pre- and post-application for achieving productivity in the educational laboratory for hand-weaving, in favor of the post-application.
- 6- There are statistically significant differences among the mean of degrees in the pre- and post-application for achieving performance in the educational laboratory for hand-weaving, in favor of the post-application.
- 7- There are statistically significant differences among the mean of degrees in the pre- and post-application of achieving aesthetics in the educational laboratory for hand weaving, in favor of the post-application.

Research methodology:

This research followed the descriptive analytical approach in describing and analyzing the components of the educational laboratory for the field of hand-weaving art, and the extent of their compatibility with occupational health and safety factors, and their suitability for the educational process by identifying the field of ergonomics and the related means of security and safety.

Research sample:

The research sample consisted of "15" specialists to survey their opinions on the design of the educational laboratory for hand-weaving.

Research tools:

➤ A questionnaire for employing the ergonomic standards in designing an educational laboratory for hand-weaving:

Questionnaire included six axes:

The first axis: Safety: consisted of "6" phrases.

The second axis: Comfort: consisted of "7" phrases.

The third axis: Ease of Use: consisted of "5" phrases.

The fourth axis: Productivity: consisted of "6" phrases.

The fifth axis: Performance: consisted of "5" phrases.

The sixth axis: Aesthetics: consisted of "7" phrases.

Research limits:

➤ **Objective limits:** Employing the ergonomic standers in designing an educational laboratory for hand-weaving.

➤ **Temporal boundaries:** The research was conducted in 2024 AD.

➤ **Spatial boundaries:** Educational institutions and training institutes.

Theoretical Framework:

Ergonomic Concepts:

Ergonomics is a Greek word composed of "Ergon" meaning work, and "Nomos" meaning rules, which means a set of rules that regulate work activities (Amal Bakkar, 2017 AD, 10). Ergonomics is a science that specializes in studying the interaction between humans and other elements through information, theories, and designing methods with the aim of improving life and the work environment to be compatible with the needs and skills of individuals. It is also a general term that refers to the standards of designing products and the individual's needs for safety and to work efficiently (Abdul Nabi Abu Al-Majd, 2006 AD, 80).

Ergonomics includes the use of all means and materials in designing products and tools, the place and method of work to suit the design goals, and improving the functional integration among individuals within the workplace, thus achieving a positive impact on performance and production rates (Karwowski, M, 2014, 62).

Ergonomics is the scientific study that helps study human factors and their relationship to the work environment and the design of equipment and products. It is the science concerned with designing products for the user to achieve a comfortable life and adapting to the workspaces, tasks, and tools in a manner that minimizes stress and risks (<http://www.ergo.eg.com/index.php>).

Ergonomics is the art of designing for the comfort and well-being of humans through designing the place and environment of work. It includes science, art, culture, and style; so it is known as human factors engineering, as it is the scientific study of humans in their work environment. The environment can be identified as everything that surrounds a person, including sounds, noise, light, heat, ventilation, tools, machines, and work methods. "Researcher's definition"

There is a set of concepts related to considerations, standards, and the work environment, which the researcher explains as follows:

- **Ergonomics Considerations:** A branch of science concerned with understanding the interaction between humans and other components in their life system. It is a profession that applies scientific theories, principles, data, and appropriate methods in designing something (Ahmed Wahid, 2010 AD, p. 7).
- **Work Environment:** The work environment affects working conditions, comfort, safety, job satisfaction, health, and ultimately productivity. The work environment includes everything related to the workplace in terms of climate, lighting, temperature, and space. Climate varies according to age, gender, and physique; thus, all physical factors must be studied and matched to the needs of the job (Amal Bakkar, 2017 AD, 40).

Ergonomics is interested in the work environment in general, and educational laboratories in particular, re-engineering and reorganizing them, with the necessity of redesigning processes in light of the technological revolution, with the aim of achieving real development in cost and quality and reducing time and effort. It is also interested in improving the relation among the user, his work tools, and the environment in which he works, to increase his efficiency and make the work environment easier (Aida Ahmed Khawaldeh, 2016 AD, 52).

The design and implementation of any artistic work must achieve its desired goal to be successful; this will not happen without providing the appropriate environment and creating an integrated formula between it and the vocabulary with which it deals. The ideal work environment is considered a true measure of the quality of design. The work environment is concerned with two main aspects:

- **Comfort:** It is considered one of the most important aspects of the work environment to address the psychological and physical aspects, which is reflected in the product and increases the user's efficiency and effectiveness. Comfort also reflects on the mental side, which helps the user to find innovative methods and creative ideas.
- **Efficiency:** An important axis to make the educational process more quality, because reducing the amount of training required and making it more comfortable and easier allows a greater number of individuals to perform tasks, which is positively reflected in its efficiency and effectiveness and increases its ability to innovate and create, and benefits the product (Bassem Hassan Abdo, 2006 AD, 103).

Ergonomic standards:

The standards that are determined to apply appropriate scientific theories, principles, and methods in design. It is a science used to achieve balanced optimal performance between the strengths and weaknesses between humans and machines. It is a set of organizational measurements, concepts, and technical controls that are implemented and observed in order to raise the quality of performance and work efficiency and reduce errors (Amal Bakkar, 2017, 3). These standards summarized as follows:

- 1- **Safety:** Every product should be designed to ensure user safety and provide a comfortable working environment. This is addressed throughout the designing process.
- 2- **Comfort:** The product should be comfortable and compatible with the user's physical abilities.
- 3- **Ease of use:** Ease of use in designing the product helps in meeting the user's needs in a tangible way.
- 4- **Productivity:** The elements included in the product design should be clear and help increase user satisfaction, and provide more instructions that allow for solving and overcoming product design problems.
- 5- **Performance:** It is important to maintain performance levels and their efficiency, and for the designer to be concerned with organizing work to accommodate any changes that may occur when using or implementing the products.
- 6- **Aesthetics:** Aesthetics and considerations of form depend on scientific rules that must be present in products, and the designer must be interested in them in spaces and colors (Ahmed Wahid, 2010 AD, 44).

Importance of the ergonomics in developing the educational process:

Ergonomics prepares the physical conditions surrounding work that are compatible with human abilities in sensation and perception, in line with their ability to learn psychologically, motorically, and physically. It aims to achieve a level of comfort, safety, and satisfaction in the work environment, based on a set of scientific theories and governing principles to achieve its effectiveness. Ergonomics does not focus solely on human behavior and performance, or systems design, as some see it, or the human capabilities related to design; rather, it extends beyond that to encompass the entirety of the work environment, in addition to the dynamic interaction of these components, such as the organized environment, its work system and design, machinery, technology, individuals, and work groups (Manar Jaber, 2019 AD, 61).

In the educational field, ergonomics is based on a philosophy that leads to psychological and individual differences among individuals in their abilities, talents, willingness to work, previous experience, and level of intelligence. Consequently, their motivation and enthusiasm for completing tasks in the work environment vary (Aida Ahmed Khawaldeh, 2016 AD, p. 14).

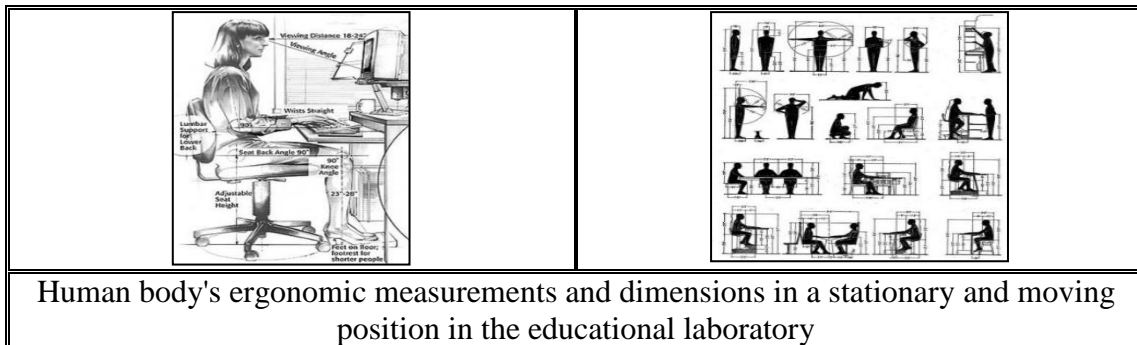
Perhaps increasing productivity without exerting strenuous effort is one of the most important indicators of performance improvement that the application of ergonomics relies on and its use in the workplace; this is achieved by providing an ideal environment for individuals, embodied in the ability to control, flexibility in performance, ease of movement during work, and the ability to utilize physical conditions, machines, and tools to skillfully complete work (Hana'a Ahmed Attia, 2013 AD, p. 103).

The higher education system is being developed and the efficiency of the educational process and its outcomes improved by organizing training courses for faculty members, providing effective educational and financial resources, and human

resources, as well as introducing innovative scientific methods and strategies to keep pace with modern developments and meet the needs of the labor market.

The ergonomics specialist focuses on the principles of industrial engineering, psychology, anthropometry, and biomechanics to achieve adaptation and compatibility with the components of the educational environment by designing machines, tools, and workplaces to suit the sizes, shapes, and physical strengths of workers, to reach:

- Creating harmony and compatibility between the physical and mental needs of work performance.
- Achieving aesthetic aspect and functional performance (diversity and innovation) in the weaving designing process.
- Saving time and effort and reducing the potential for error in weaving designing.
- Design program and its suitability in order to meet the requirements of the user and his needs.
- Implemented the designs easily, and seeing the final product before implementation.
- Presenting new ideas and innovative designs to meet all the needs of designers and students (Amer Abd El-Latif, 2012 AD, 45).



Human body's ergonomic measurements and dimensions in a stationary and moving position in the educational laboratory

Areas of ergonomics:

➤ Physical Ergonomics:

A branch of ergonomics that examines the physical, anatomical, and physiological attributes of the human body and its relation to the designing of machines, equipment, products, and work systems that humans interact with, and that to provide safety and a comfortable environment for him, also this field focuses on anthropometric measurements and human biomechanical characteristics to be used as standards for designing products and physical activities. Topics studied by this branch of ergonomics include work positions and manual handling of materials, repetitive movements, diseases and muscular pathological symptoms, and organizing the workspace in a manner consistent with the functional range of human body organs. It also focuses on aspects of safety, human health, and safety through healthy and safe interactions between the human element and other elements in the work environment. This is achieved through the proper design of these elements, the evaluation and

analysis of various works activities and functions, and the study of the work environment (Ahmed Wahid, 2010 AD, p. 17).

	<p>Ergonomic measurements of the human body in sitting positions during work, we notice on the right side the wrong positions, where there is a clear distance between the person's back and the seat where the angle widens and increases, and the correct sitting position is when the distance between the person's back and the back of the seat is small where the angle narrows, as well as the position of the head, neck and shoulders in the wrong position when sitting on the right side so that the distance needed by the person increases compared to the correct position</p>
	<p>The human body ergonomic measurements in positions of sitting and the relation between the proportion and measurements of seats and the human body ergonomic measurements. We notice that the seat shown on the right side is considered the typical seat for the human body, as we see the head resting on the upper seat, the height of the seat is appropriate for the human back, while in the left seat we notice the head is not resting on it due to the shortness of the seat back, and in the middle we find that the upper sides of the seat hinder the expansion of the shoulders.</p>
	<p>Ergonomic measurements of the human body in movement positions, the distance needed when using books from shelves, when placing his things, and the distance needed for height.</p>
	<p>Ergonomic measurements of the human body in the movement required during the maintenance and cleaning of laboratories, including their devices and equipment, and the provision of short ladders for use in maintaining and cleaning high places.</p>

➤ Mental Ergonomics:

This field examines human mental traits and abilities, such as sensory perception, the ability to understand, remember, use logic in deduction and inference, and motor responses; this is done by examining the impact of these factors on the interaction between human and other components of the systems he deal with. Topics dealt by this field include mental workloads, decision-making, skill performance, human interaction with smart machines, psychological work efforts, and training methods (Mohammed Ahmed Abd El-Khaleq, 2019 AD, p. 22).

➤ **Organizational Ergonomics:**

This studies how to achieve the maximum benefits of technical and social systems, including their organizational components and processes. Topics dealt by this field include communication and human resource management, work design and its scheduling and times, teamwork and participatory design, collaborative work, and organizational culture, total quality and quality of administrative work (Aida Ahmed Khawaldeh, 2016 AD, 14).

➤ **Environmental Ergonomics:**

This field examines the environmental impact on work, including considerations of the thermal environment; also the auditory environment also constitutes an important aspect of this field. It also focuses on the visual environment, lighting, visual pollution, and the impact of these factors on human and the systems and products he interact with (Basem Hassan Abdo, 2006 AD, 9).

➤ **Emotional Ergonomics:**

This field measures the availability of aesthetics, enjoyment, comfort, tranquility, and safety. It also measures the effects of the nature of the place, specifically in a weaving laboratory, in terms of narrow space, for example, and its impact on the psychological state of trainees. It also examines the impact of temperature, humidity, and ventilation (Asma'a Mamdouh, Rasha Rashad, 2018 AD, 11).

The effectiveness of ergonomics in designing and establishing an educational laboratory for hand-weaving:

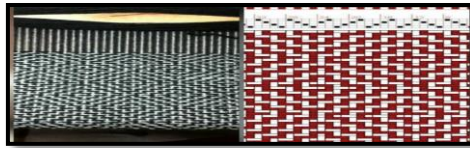
The field of weaving is one of the creative, applied fields that depends on a technical aspect and scientific and technological developments. Its implementation requires equipment such as looms, seats, and storage areas for materials used, such as various threads and weaving tools; other factors include ventilation, lighting, and sound insulation, as well as an integrated design for the place that accommodates the specified number of attendees and their movement within the laboratory. The place also requires tables for designing, as it is one of the innovative practical fields based on stages and implementation steps that require prior planning, including:

- Presenting the idea of the work and sources of inspiration, such as (nature, heritage, various arts, or reworking an artwork).
- Developing an appropriate design and evaluating it according to the nature of the implementation, under the direct guidance of the trainer to the trainee.
- Selecting color combinations according to the design.
- Clarifying the steps of working on the loom.
- Presenting a practical demonstration of the implementation method.
- Beginning work on the loom with continuous guidance.
- Continuous monitoring of the implementation method.
- Finishing textile and finishing works.

This is an attempt to find innovative educational approaches according to the aforementioned ergonomic standards. Hand-woven textiles are considered one of the

creative products directly influenced by ergonomics, which requires developing the current educational environment to be suitable for these innovative standards, thus improving the educational environment and, consequently, improving the quality of educational outcomes to meet the requirements of the labor market in the field of hand-woven textiles. This is what this research seeks to shed light on, as well as the extent to which ergonomic standards are relevant to solving problems related to the educational environment and its components, which include weaving laboratories in educational institutions. This research aims to advance the field, from the design process to the final product, with providing all means of safety, comfort, and security for students.







Electronic programs for hand weaving have developed greatly in recent times and have been provided with great capabilities that allow them to perform everything that is important to those work in the hand weaving industry with ease and convenience, so that it has become possible to complete a textile design in a short period of time, provide a complete picture of the design's shape, and work to solve any problems or defects that may appear in the final form (AVL Home Loom with Compu-Dobby III. 2002. 10).



Designing and constructing the woven design "<http://www.weavepoint.com>"

Educational programs, teaching strategies, and laboratory organization have evolved, which tempts to use modern technological programs in the hand-weaving industry. This industry, the researcher, through her studies, seeks to re-establish, especially since the Kingdom of Saudi Arabia has a pioneering aspect that represents its most important creative heritage. This requires preserving this industry from extinction amid rapid development and the introduction of machines, which threatens the creative hand-works.

The importance of the educational process lies in preserving the cultural heritage through the development of this industry and protecting it from extinction. It also aims to preserve the traditional folk heritage to establish and develop this profession in line with scientific and technological developments. The loom is the most important component of the hand-weaving laboratory, which produces a variety of creative products. There are also many types of hand-weaving looms, ranging from simple looms, pendant looms, rugs, carpets, comb looms, and table looms. (<https://shaaraf.com/ar/2019/05/14/weaving-loom-part2/>).

	
<p>Modern hand looms and how to coordinate them in the work environment "https://avllooms.com/collections/looms"</p>	
	
<p>Modern hand looms and how to coordinate them in the work environment "Workshop Dobby Loom – AVL Looms Inc"</p>	
	
<p>Proper planning for organizing a weaving laboratory "Sigrid Piroch: 2004"</p>	

Research Procedures:

Proposed design for an educational laboratory for hand-weaving arts:

Educational Laboratory:

This refers to the work environment, including the place equipped for the laboratory, tools, devices, and equipment. Laboratories vary in their preparation and equipment those should be use from tools and laboratory equipment should be used, depending on the type of training and the time period the user spends completing the required work.

Main Functions of the laboratory:

- **Learning and understanding the nature of science and technology:** Hand-weaving is a practical field taught in educational laboratories with special equipment and a distinct nature.

- **Learning problem-solving skills:** Problem-solving strategy is a learning method, also known as the scientific method of thinking. It relies on specific skills related to the nature of the field and its techniques. These skills are entirely dependent on the user's training in the techniques specific to the art of weaving.
- **Acquiring manual skills:** The laboratory is important in developing attendees' skills in executing the required textile pieces according to the performance stages. These skills include preparing the loom, using tables, using drawing tools and colors in design processes, and preparing and tightening the warp threads. Design and work ideas are also subject to a brainstorming strategy, followed by an analysis of the main ideas and results compared to practical application processes and the final product.
- **Learning the main principles and ideas of science:** The laboratory is important in reaching the results and information related to design, skills, and learning strategies related to the art of weaving, learning resources, and inspiration.
- **Developing attitudes, interests, and values:** Laboratory training encourages attendees to develop and love manual work, and it also develops their ability to think, imagine, and cooperate.

Managing Work in the Educational Laboratory:

Performing educational laboratory activities requires appropriate management to implement them and achieve the desired results; this is subject to several procedures, including:

- **Identifying research problems:** related to the stages of work, beginning from the idea to the implementation processes, until the final product is achieved.
- **Directing users to the laboratory work to be performed and completed:** related to the required weaving work and implementation method.
- **Dividing users into work groups:** to achieve the targeted educational outcomes according to cooperative group work mechanisms.
- **Determining a logical order for laboratory work:** Work groups are identified according to the nature of the laboratory activities. The supervisor prepares a list of the tasks to be completed and directs attendees to complete these tasks according to their order in that list.
- **Laboratory work follow-up:** This step is crucial to the educational work, and the success of the attendees in the laboratory depends on it. It includes continuous follow-up of the attendees during their work. Continuous evaluation of work is achieved through:
 - Holding meetings with attendees during the educational process in the laboratory.
 - Continuously observing attendees during work and continuously correcting their workflow.
 - Writing reports on the nature and stages of the work performed by attendees individually, or the work performed by the group as a whole. These reports are discussed in ongoing work sessions to correct the course of the laboratory work to achieve its objectives.

■ **Laboratory safety:** Safety conditions and requirements in the laboratory must be observed to reduce accidents and back and wrist injuries resulting from prolonged sitting while producing the required textile pieces. General safety rules must be placed in a prominent location for attendees to view. These rules include:

- Knowing how to use the tools, devices, and safety equipment available in the laboratory and their locations.
- Attendees must wear safety goggles or similar safety means when performing work that may harm their eyes.
- Attendees must wear coats while working in the laboratory.
- Users are prohibited from eating or drinking while working in the laboratory.
- The educational educator must record laboratory accidents and prepare adequate reports.
- Clean the surface of laboratory benches after work, and turn off water and electricity sources.
- Clean laboratory equipment after work, return it to its original location, and store it there.
- Providing mini-pharmacies for first aid and modern medical tools.

■ **Providing specialized technicians females in the field of textile art to work in the laboratory:** "3" full-time, "2" shifts, and "2" reserve. These technicians will assist attendees in preparing the educational laboratory, ensuring security and safety measures, organizing plasma screen displays, submitting weekly reports on daily achieved works, supervising the updating of bulletin boards, monitoring the laboratory's furniture, inventory, restoration, needs, and ravages, monitoring laboratory maintenance for all equipment, and preparing looms.

To achieve ergonomic standards in the design of educational laboratories that are compatible with safe and comfortable use, we must profit from the role of ergonomics in designing educational facilities to achieve quality in the educational process and product. This can be achieved by developing an appropriate design for an educational laboratory for the art of hand-weaving with ergonomic specifications that serve educational institutions and society.

- Educational laboratory requirements: The educational laboratory environment, tools, devices, and equipment, lighting, ventilation, electricity, security and safety.
- The number of attendees must be compatible with the educational laboratory space: In terms of appropriate space for each person, according to general anthropometric measurements.
- Consideration of people with disabilities and special needs: The educational laboratory design must be compatible with people with disabilities and special needs in terms of equipment.

Proposed ergonomic considerations in designing a hand-weaving educational laboratory:

First: Environmental:

- **Laboratory space:** Entrance (doors and their specifications): The main laboratory door is made of wood with a tight glass window that allows for outside views and is soundproof.

- **Windows and their specifications:**

- 1- A large glass window on the front facade, allowing natural light.
- 2- Two side windows on the front wall of the laboratory, measuring 1m wide x 2m high, that can be opened.

- **Photography area:** The laboratory is equipped with a corner for photography and videography, and is equipped with special lighting.

- **Gallery or museum:** The laboratory contains heritage and contemporary textiles displayed in two glass showcases that can be viewed from both inside and outside the lab.

- **Library:**

- Open shelves for storing books and specialized scientific references on everything taught in the laboratory.
- Providing reference materials from the library's holdings, such as dictionaries, glossaries, encyclopedias, and encyclopedias.
- The library subscribes to many periodicals specializing in textile art (printed paper, film materials, CDs).
- The library is equipped with a table, cabinets, shelves, and four chairs.

- **Restrooms:**

- Providing restrooms: one for the teaching staff, another for people with disabilities, and four for the general public.

- **Development Area :**

- A section dedicated to future development that is expandable. It is preferable to use a spider design in the construction process to accommodate developments in the curriculum, tools, and equipment.

- **Environmental considerations for designing a laboratory for people with disabilities and special needs:**

- Providing the necessary spaces that allow the disabled person to move and see clearly.
- Selecting appropriate spaces for the disabled, such that they are located on the edges of corridors and lines, on flat areas, and near services and emergency doors.
- Special tables for people with mobility disabilities.

Second: In terms of tools:

Required furniture and its specifications:

- **Large moving looms:** (6) looms to be used by (12) female students at one time.

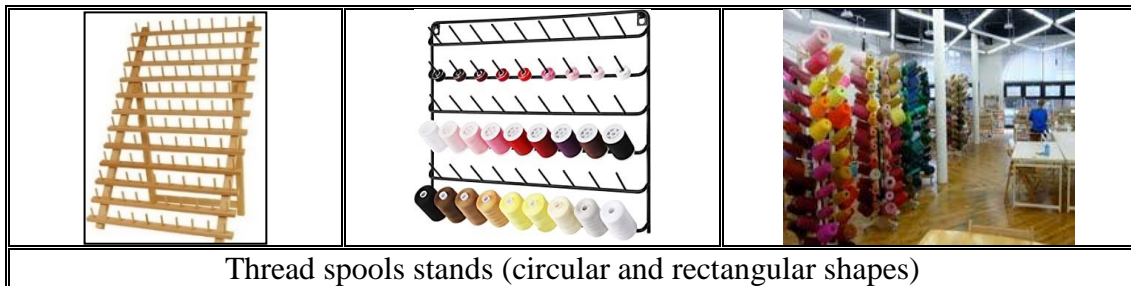


- **Wooden frames fixed in the corner that can be rotated and moved in both directions:** They can hold (5) wooden frames, each frame is used on both sides to display the distinctive works.



Wooden frames fixed in the corner to display woven artwork

- **Thread spools stand:** It has circular motion and is equipped with wheels at the bottom to allow transmission.



The remaining furniture is divided into:

❖ Chairs:

- Number of "12" green leather backless chairs for looms with wheels.
- Number of "20" chairs for large tables with grey leather backs and wheels. Grey was chosen because it withstands dust and stains and does not affect the colors of the threads during the implementation of artworks.
- Number of "6" fixed grey leather computer chairs with backs.
- Number of "4" movable grey leather library chairs with foldable backs.

- Number of "1" grey leather two-seat sofa for the audiences.
- Number of "1" green leather chair with back, armrests, and wheels for the teacher.

❖ Tables:

- A front desk for the professor.
- Number of "2" large beige wood tables with fixed legs for audiences, each table up to 8 people.
- Number of "6" fixed beige computer tables on the right wall.
- Number of "2" round, beige, foldable tables.
- A rectangular, 1m x 70cm, beige table for the audience sofa.

❖ Curtains:

- Corner curtains fixed in the ceiling in the left corner of the laboratory, used for the photography area.



Curtains of Photography room

❖ Cabinets and Cupboards:

- A ceiling-height wall cabinet, shaped like a corner, on the far right of the laboratory. This cabinet serves as a library for books and references, divided into upper shelves and lower cupboards. It's made of beige wood and features an internal lighting unit.
- A ceiling-height wall cabinet, shaped like a corner, serves as a glass showcase for photography with internal lighting, covered with a black corner curtain.
- A glass showcase on the entrance wall, 3 meters high, displays both ancient heritage and contemporary works. It can be seen from both the outside and inside.
- On the same wall are lockers for attendees to store their hand luggage while working. There are 20 lockable cabinets.
- A wall cabinet in the bathroom behind the door is equipped with first aid, a fire extinguisher and bathroom supplies.



Cabinets







Glass showcase for exhibits inside the laboratory

Lighting, Ventilation, and Electricity:



- **Ventilation aspirators:** Ventilation aspirators for the laboratory are installed in the ceiling (entrance) and in the bathrooms, commensurate with the laboratory's size and specifications for healthy, proper ventilation.
- **Lighting and Electrical Power:** Electrical power is distributed within the laboratory along axes commensurate with the function of each axis.

Instrument and Equipment:

- Number of "7" computers: "6" for attendance and one for the teacher.
- Number of "2" printers: one for attendance and one for the teacher.
- Number of "1" ceiling-mounted projector and one mobile projector.
- Number of "1" ceiling-mounted display screen suitable for both of the above devices.
-

			
Projector	Mobile projector	Display screen	

- Magnifying lenses installed on the left wall (6) to illuminate each loom, and each one has a control button that is steerable, allowing it to be moved in all directions to follow the performance.

	
Fixed amplifier	

- Six mobile desk spotlights are placed next to the computers.
- A professional digital camera for photographing artwork (especially for the laboratory's photo corner).
- An interactive whiteboard in the educational laboratory, along with its requisites.
- Equipment is available for people with physical, visual, and hearing disabilities.

Proposed chart: Distribution of educational laboratory requirements and movement within it according to ergonomic standards and standard specifications:

It is clear from the table that all the correlation coefficients are significant at the level (0.01- 0.05) because they are close to the whole one, which indicates the validity and homogeneity of the questionnaire phrases.

The second axis: Comfort:

Sincerity has been calculated using internal consistency by calculating the correlation coefficient (Pearson correlation coefficient) between the degree of each phrase and the degree of the axis (**Comfort**), and the following table shows that:

Table (2) values of the correlation coefficients between the degree of each phrase and the degree of the axis (Comfort)

S	Correlations	Significance
1-	0.945	0.01
2-	0.764	0.01
3-	0.888	0.01
4-	0.629	0.05
5-	0.732	0.01
6-	0.641	0.05
7-	0.865	0.01

It is clear from the table that all the correlation coefficients are significant at the level (0.01- 0.05) because they are close to the whole one, which indicates the validity and homogeneity of the questionnaire phrases.

The third axis: Ease of Use:

Sincerity has been calculated using internal consistency by calculating the correlation coefficient (Pearson correlation coefficient) between the degree of each phrase and the degree of the axis (**Ease of Use**), and the following table shows that:

Table (3) values of the correlation coefficients between the degree of each phrase and the degree of the axis (Ease of Use)

S	Correlations	Significance
1-	0.921	0.01
2-	0.748	0.01
3-	0.809	0.01
4-	0.615	0.05
5-	0.716	0.01

It is clear from the table that all the correlation coefficients are significant at the level (0.01- 0.05) because they are close to the whole one, which indicates the validity and homogeneity of the questionnaire phrases.

The fourth axis: Productivity :

Sincerity has been calculated using internal consistency by calculating the correlation coefficient (Pearson correlation coefficient) between the degree of each phrase and the degree of the axis (**Productivity**), and the following table shows that:

Table (4) values of the correlation coefficients between the degree of each phrase and the degree of the axis (Productivity)

S	Correlations	Significance
1-	0.638	0.05
2-	0.895	0.01
3-	0.957	0.01
4-	0.775	0.01
5-	0.603	0.05
6-	0.838	0.01

It is clear from the table that all the correlation coefficients are significant at the level (0.01- 0.05) because they are close to the whole one, which indicates the validity and homogeneity of the questionnaire phrases.

The fifth axis: Performance:

Sincerity has been calculated using internal consistency by calculating the correlation coefficient (Pearson correlation coefficient) between the degree of each phrase and the degree of the axis (**Performance**), and the following table shows that:

Table (5) values of the correlation coefficients between the degree of each phrase and the degree of the axis (Performance)

S	Correlations	Significance
1-	0.726	0.01
2-	0.781	0.01
3-	0.902	0.01
4-	0.849	0.01
5-	0.627	0.05

It is clear from the table that all the correlation coefficients are significant at the level (0.01- 0.05) because they are close to the whole one, which indicates the validity and homogeneity of the questionnaire phrases.

The sixth axis: Aesthetics:

Sincerity has been calculated using internal consistency by calculating the correlation coefficient (Pearson correlation coefficient) between the degree of each phrase and the degree of the axis (**Aesthetics**), and the following table shows that:

Table (6) values of the correlation coefficients between the degree of each phrase and the degree of the axis (Aesthetics)

S	Correlations	Significance
1-	0.873	0.01
2-	0.755	0.01
3-	0.644	0.05
4-	0.938	0.01
5-	0.616	0.05
6-	0.964	0.01
7-	0.812	0.01

It is clear from the table that all the correlation coefficients are significant at the level (0.01- 0.05) because they are close to the whole one, which indicates the validity and homogeneity of the questionnaire phrases.

Sincerity by using the internal consistency between the total degree of each axis and the total degree of the questionnaire:

Sincerity has been calculated using internal consistency by calculating the correlation coefficient (Pearson correlation coefficient) between the total degree of each axis (**Safety, Comfort, Ease of Use, Productivity, Performance, Aesthetics**) and the total degree of the questionnaire; and the following table shows this:

Table (7) values of the correlation coefficients between the total degree of each axis (Safety, Comfort, Ease of Use, Productivity, Performance, Aesthetics) and the total degree of the questionnaire

	Correlations	Significance
The first axis: Safety	0.761	0.01
The second axis: Comfort	0.829	0.01
The third axis: Ease of Use	0.737	0.01
The fourth axis: Productivity	0.883	0.01
The fifth axis: Performance	0.851	0.01
The sixth axis: Aesthetics	0.796	0.01

It is clear from the table that all the correlation coefficients are significant at the level (0.01) because they are close to the whole one, which indicates the validity and homogeneity of the questionnaire axes.

Reliability:

Reliability means the accuracy of the test in the measurement and observation, and it does not a contradiction with itself, and its consistence with what it providing us with information about the examiner's behavior, and it is the ratio between the variance of

the degree on the questionnaire that indicates the actual performance of the examiner, and the reliability has been calculated by:

- 1- Alpha Cronbach coefficient
- 2- Split-half method

Table (8) values of the reliability coefficient of the questionnaire axes of employing the ergonomic standards in designing an educational laboratory for hand-weaving

Axes	Alpha coefficient	Split-half
The first axis: Safety	0.854	0.813 – 0.899
The second axis: Comfort	0.925	0.884 – 0.961
The third axis: Ease of Use	0.827	0.785 – 0.866
The fourth axis: Productivity	0.793	0.752 – 0.834
The fifth axis: Performance	0.902	0.866 – 0.942
The sixth axis: Aesthetics	0.756	0.712 – 0.797
Reliability of the questionnaire of employing the ergonomic standards in designing an educational laboratory for hand-weaving as whole	0.881	0.846 – 0.921

It is clear from the previous table that the all values of the reliability coefficients: the Alpha coefficient, the Split-half are significant at the level of 0.01 and that indicates the reliability of the questionnaire.

Research results:

The first hypothesis:

The first hypothesis states the following:

"There are statistically significant differences among the mean of degrees in the pre- and post-application for employing the ergonomic standards in designing an educational laboratory for hand-weaving, in favor of the post-application".

To verify this hypothesis, the (t) test was applied, and the following table shows that:

Table (9) Significant of differences among the mean of degrees in the pre- and post-application for employing the ergonomic standards in designing an educational laboratory for hand-weaving "Effectiveness"

Effectiveness	Arithmetic mean "M"	standard Deviation	Number of sample individuals "N"	degrees of freedom "df"	Value of " t "	Significance level and its direction
Pre-application	64.146	4.227	15	14	41.662	0.01 In favor of post-application
Post-application	99.271	7.059				

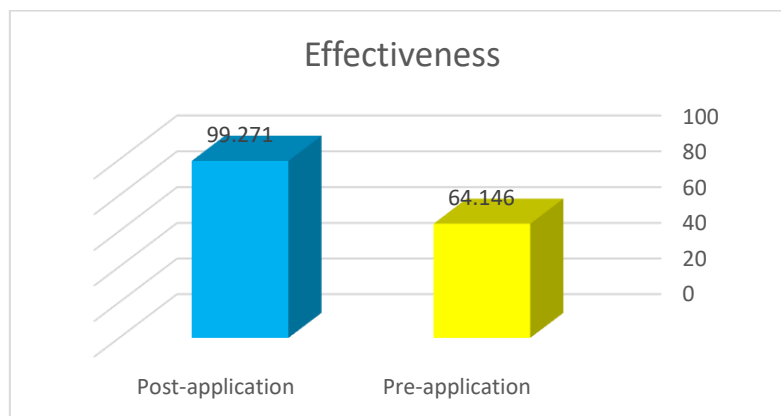


Chart (2) Significant of differences among the mean of degrees in the pre- and post-application for employing the ergonomic standards in designing an educational laboratory for hand-weaving "Effectiveness"

From table (9) and chart (2), it is clear that the value of (**t**) was (41.662), and it is a statistically significant value at the significance level of (0.01), where the mean of degrees in the Post-application was (99.271), while the mean of degrees in the Pre-application was (64.146), which indicates that there are real differences between the two applications in favor of the post-application, which indicates the effectiveness of employing the ergonomic standards in designing an educational laboratory for hand-weaving.

To know the size of the effect, the Eta equation was applied: **t = value (t) = 41.662, df = degrees of freedom = 14**

$$n^2 = \frac{t^2}{t^2 + df} = 0.99$$

By calculating the effect size, it was found that $n^2 = 0.99$

$$d = \frac{2 \sqrt{n^2}}{\sqrt{1-n^2}} = 19.8$$

The size of the effect is determined whether it is large, medium, or small as follows:

- 0.2 = small effect size
- 0.5 = medium effect size
- 0.8 = large effect size

This means that the size of the effect is large, thus **the first hypothesis was verified.**

The second hypothesis:

The second hypothesis states the following:

"There are statistically significant differences among the mean of degrees in the pre- and post-application for achieving safety in the educational laboratory for hand-weaving, in favor of the post-application".

To verify this hypothesis, the (**t**) test was applied, and the following table shows that:

Table (10) Significant of differences among the mean of degrees in the pre- and post-application for achieving safety in the educational laboratory for hand-weaving

Safety	Arithmetic mean "M"	standard Deviation	Number of sample individuals "N"	degrees of freedom "df"	Value of "t"	Significance level and its direction
Pre-application	10.158	1.011	15	14	8.132	0.01 In favor of post-application
Post-application	16.224	1.527				

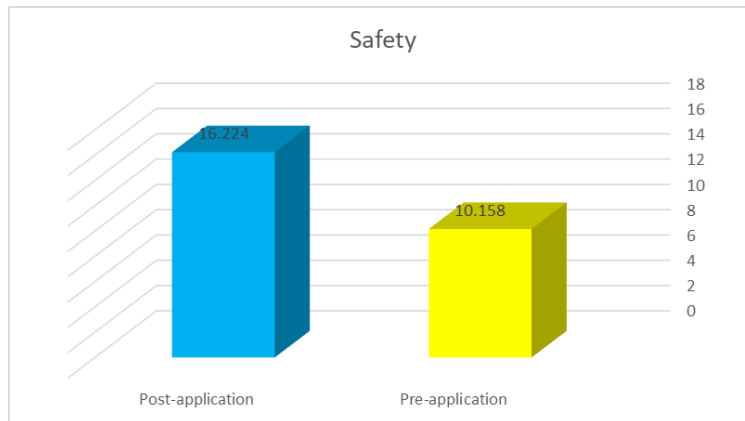


Chart (3) Significant of differences among the mean of degrees in the pre- and post-application for achieving safety in the educational laboratory for hand-weaving

From table (10) and chart (3), it is clear that the value of (t) was (8.132) for achieving safety, and it is a statistically significant value at the significance level of (0.01) in favor of the Post-application, where the mean of degrees in the Post-application was (16.224), while the mean of degrees in the Pre-application was (10.158), thus **the second hypothesis was verified.**

The third hypothesis:

The third hypothesis states the following:

"There are statistically significant differences among the mean of degrees in the pre- and post-application for achieving comfort in the educational laboratory for hand-weaving, in favor of the post-application".

To verify this hypothesis, the (t) test was applied, and the following table shows that:

Table (11) Significant of differences among the mean of degrees in the pre- and post-application for achieving comfort in the educational laboratory for hand-weaving

Comfort	Arithmetic mean "M"	standard Deviation	Number of sample individuals "N"	degrees of freedom "df"	Value of "t"	Significance level and its direction
Pre-application	11.016	1.540	15	14	9.103	0.01 In favor of post-application
Post-application	18.553	2.134				

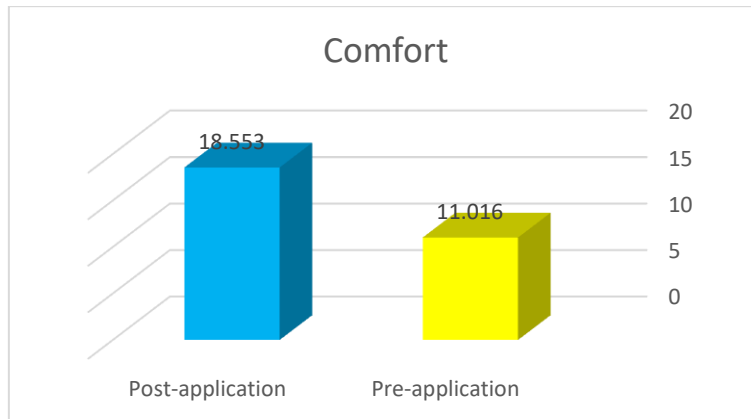


Chart (4) Significant of differences among the mean of degrees in the pre- and post-application for achieving comfort in the educational laboratory for hand-weaving

From table (11) and chart (4), it is clear that the value of (t) was (9.103) for achieving comfort, and it is a statistically significant value at the significance level of (0.01) in favor of the Post-application, where the mean of degrees in the Post-application was (18.553), while the mean of degrees in the Pre-application was (11.016), thus **the third hypothesis was verified.**

The fourth hypothesis:

The fourth hypothesis states the following:

"There are statistically significant differences among the mean of degrees in the pre- and post-application for achieving ease of use in the educational laboratory for hand-weaving, in favor of the post-application".

To verify this hypothesis, the (t) test was applied, and the following table shows that:

Table (12) Significant of differences among the mean of degrees in the pre- and post-application for achieving ease of use in the educational laboratory for hand-weaving

Ease of use	Arithmetic mean "M"	standard Deviation	Number of sample individuals "N"	degrees of freedom "df"	Value of " t "	Significance level and its direction
Pre-application	9.039	1.145	15	14	7.762	0.01 In favor of post-application
Post-application	14.147	1.816				

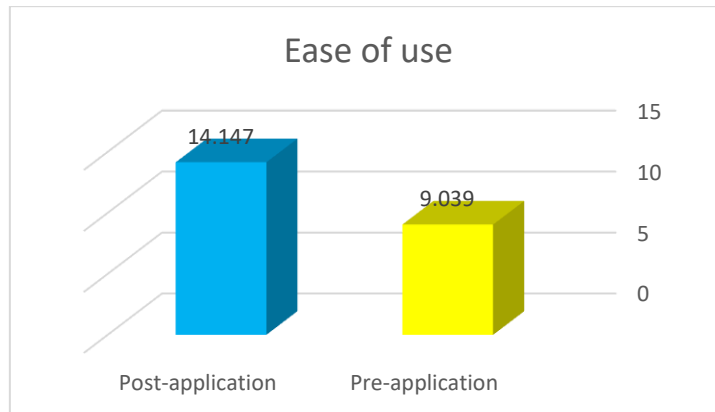


Chart (5) Significant of differences among the mean of degrees in the pre- and post-application for achieving ease of use in the educational laboratory for hand-weaving

From table (12) and chart (5), it is clear that the value of (t) was (7.762) for achieving ease of use, and it is a statistically significant value at the significance level of (0.01) in favor of the Post-application, where the mean of degrees in the Post-application was (14.147), while the mean of degrees in the Pre-application was (9.039), thus **the fourth hypothesis was verified.**

The fifth hypothesis:

The fifth hypothesis states the following:

"There are statistically significant differences among the mean of degrees in the pre- and post-application for achieving productivity in the educational laboratory for hand-weaving, in favor of the post-application".

To verify this hypothesis, the (t) test was applied, and the following table shows that:

Table (13) Significant of differences among the mean of degrees in the pre- and post-application for achieving ease of use in the educational laboratory for hand-weaving

Productivity	Arithmetic mean "M"	standard Deviation	Number of sample individuals "N"	degrees of freedom "df"	Value of " t "	Significance level and its direction
Pre-application	13.570	1.429	15	14	5.051	0.01 In favor of post-application
Post-application	17.293	2.381				

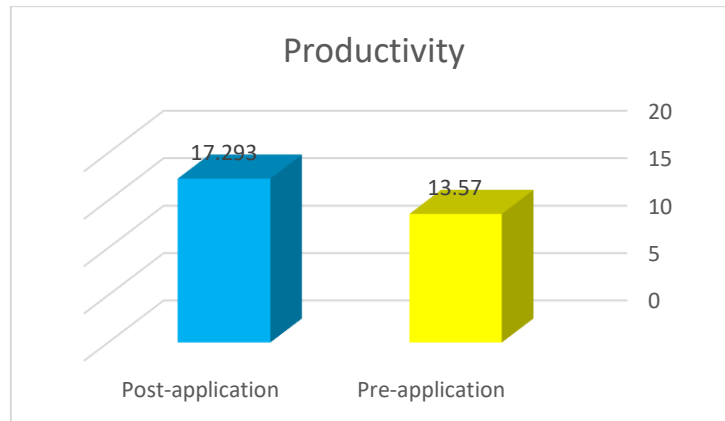


Chart (6) Significant of differences among the mean of degrees in the pre- and post-application for achieving productivity in the educational laboratory for hand-weaving

From table (13) and chart (6), it is clear that the value of (t) was (5.051) for achieving productivity, and it is a statistically significant value at the significance level of (0.01) in favor of the Post-application, where the mean of degrees in the Post-application was (17.293), while the mean of degrees in the Pre-application was (13.570), thus **the fifth hypothesis was verified.**

The sixth hypothesis:

The sixth hypothesis states the following:

"There are statistically significant differences among the mean of degrees in the pre- and post-application for achieving performance in the educational laboratory for hand-weaving, in favor of the post-application".

To verify this hypothesis, the (t) test was applied, and the following table shows that:

Table (14) Significant of differences among the mean of degrees in the pre- and post-application for achieving performance in the educational laboratory for hand-weaving

Performance	Arithmetic mean "M"	standard Deviation	Number of sample individuals "N"	degrees of freedom "df"	Value of " t "	Significance level and its direction
Pre-application	8.234	1.110	15	14	6.162	0.01 In favor of post-application
Post-application	13.709	1,863				

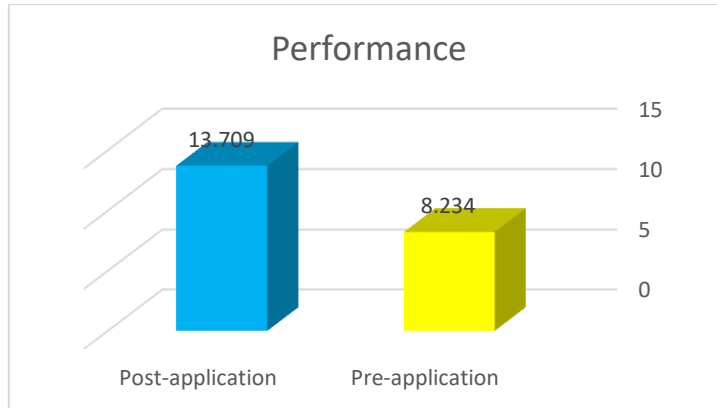


Chart (7) Significant of differences among the mean of degrees in the pre- and post-application for achieving performance in the educational laboratory for hand-weaving

From table (14) and chart (7), it is clear that the value of (t) was (6.162) for achieving performance, and it is a statistically significant value at the significance level of (0.01) in favor of the Post-application, where the mean of degrees in the Post-application was (13.709), while the mean of degrees in the Pre-application was (8.234), thus **the sixth hypothesis was verified.**

The seventh hypothesis:

The seventh hypothesis states the following:

"There are statistically significant differences among the mean of degrees in the pre- and post-application of achieving aesthetics in the educational laboratory for hand weaving, in favor of the post-application".

To verify this hypothesis, the (t) test was applied, and the following table shows that:

Table (15) Significant of differences among the mean of degrees in the pre- and post-application for achieving aesthetics in the educational laboratory for hand-weaving

Aesthetics	Arithmetic mean "M"	standard Deviation	Number of sample individuals "N"	degrees of freedom "df"	Value of "t"	Significance level and its direction
Pre-application	12.129	1.351	15	14	10.481	0.01 In favor of post-application
Post-application	19.345	2.614				

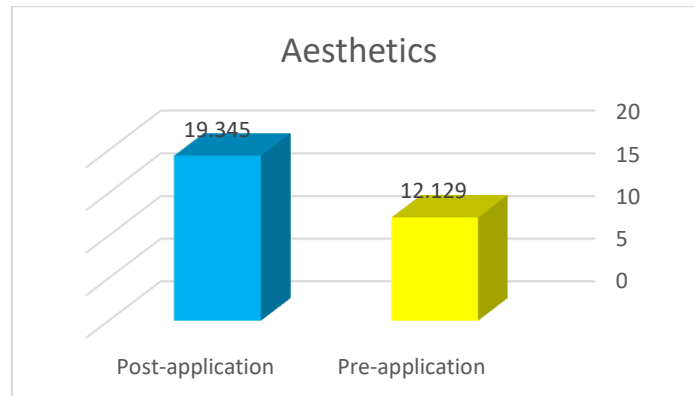


Chart (8) Significant of differences among the mean of degrees in the pre- and post-application for achieving aesthetics in the educational laboratory for hand-weaving

From table (15) and chart (8), it is clear that the value of (t) was (10.481) for achieving aesthetics, and it is a statistically significant value at the significance level of (0.01) in favor of the Post-application, where the mean of degrees in the Post-application was (19.345), while the mean of degrees in the Pre-application was (12.129), thus **the seventh hypothesis was verified.**

From the above, the researcher concluded:

- 1- Ergonomics is an engineering science related to the physical and psychological compatibility among machines, tools, the people who deal with and use them, and all components of educational laboratories. This requires a comfortable seating design that accommodates loom heights, thereby avoiding back and wrist injuries among attendees.
- 2- Ergonomics is interested in organizing the work environment, including tools, equipment, lighting, ventilation, and all comfort means, to suit the needs of attendees and those working in it, especially in practical arts fields, such as the textile laboratory in particular.
- 3- Physical ergonomics contributes to achieving harmony between the human factor, represented in the educational laboratories in general, and weaving laboratories in particular, due to the required compatibility among attendees, machines, tools, and raw materials used.
- 4- Environmental ergonomics contributes in achieving a healthy educational laboratory that is consistent with plans and strategies that with efficient and capable of competing in the labor market.
- 5- Ergonomics standards help solve problems related to hand-weaving laboratories and avoid expected errors, which achieves comfort and safety, which in turn is reflected in the nature and quality of the product.

6- Ergonomics achieves an integrated system that studies the relation among human, product, and the environment in a manner that achieves integration with other design aspects (functional, aesthetic, economic), to design a product that meets the recipient's desires and his personal needs.

7- Applying ergonomics standards in hand-weaving laboratories helps in developing their specifications for the product, increasing comfort and safety levels, and enhancing its ability to compete locally and globally.

8- Practical experiences have proven that the benefit of the scientific developments in the field of ergonomics and its standards achieves outcomes that are compatible with the requirements of the evolving labor market.

Recommendations:

1- Disseminating ergonomic culture, including its physical, environmental, organizational, and mental dimensions, in educational institutions to achieve educational outcomes that are compatible with plans and strategies and capable of competing in the labor market.

2- Linking strategies to the quality of the educational process in the field of arts and the outcomes of the educational process.

3- Taking ergonomic considerations into account in designing the educational laboratories to achieve the quality of educational outcomes.

4- Focusing on the design of tools, looms, and work environments (weaving laboratories) in accordance with ergonomic standards for safer, more comfortable, and more effective use.

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