Blended Learning for Teaching a Proposed Unit on Smart Clothing

A Experimental Study on Female Students in Industrial) Technical Education

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مجلة البحوث في مجالات التربية النوعية

معرف البحث الرقمي DOI: 10.21608/JEDU.2024.329137.2126

المجلد الحادي عشر العدد56 . يناير 2025

الترقيم الدولي

E- ISSN: 2735-3346   P-ISSN: 1687-3424

موقع المجلة عبر بنك المعرفة المصري https://jedu.journals.ekb.eg/

موقع المجلة http://jrfse.minia.edu.eg/Hom

العنوان: كلية التربية النوعية . جامعة المنيا . جمهورية مصر العربية

Blended learning to teach a proposed unit on smart clothing (A semi-experimental study on students of industrial technical education)

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مستخلص البحث

هدف البحث الحالي إلى التعرف علي فاعلية برنامج قائم علي التعليم المدمج لتدريس وحدة مقترحة عن الملابس الذكية دراسة شبه تجريبية على طالبات التعليم الفني الصناعي. واتبعت الباحثة المنهج شبه التجريبي ذا المجموعة الواحدة، ولتحقيق هدف البحث قامت الباحثة ب: 1- تصميم برنامج مقترح قائم علي التعليم المُدمج لتدريس الأقمشة الذكية ((تصميم مواقف تعليمية جديدة تمزج ما بين التدريس داخل الفصول الدراسية والتدريس عبر الإنترنت باستخدام منصة ميكروسوفت تيمز(Microsoft Teams)) حيث يتم من خلالها عرض وتقديم دروس البرنامـج. 2- بناء اختبار تحصيلي لقياس الجانب المعرفي للملابس الذكية ، وقد تم تطبيق أدوات البحث علي عينة تكونت من 33 طالبة (فصل 2-3) من طالبات الصف الثانى الثانوي الفني تخصص الملابس الجاهزة بمدرســة بني مزار الثانوية الفـنية وذلك للعام الدراســي 2023- 2014م و**توصلت نتائج الدراسة إلى:** وجود فروق دالة إحصائياً عند مستوي (α ≥ 05 ،.) بين متوسطي درجات الطالبات عينة الدراسة في القياسين القبلي والبعدى فى اختبار التحصيل المعرفي وبطاقة الملاحظة.

Abstract:

The current research aim to assess the effectiveness of a blended learning program for teaching a proposed unit on smart clothing in a quasi-experimental study involving female students in industrial technical Education. The researcher adopted a quasi-experimental design with a single group. To achieve the research objectives, the researcher: 1. Designed a proposed blended learning program for teaching smart fabrics, which included creating new educational scenarios that combined classroom instruction with online teaching using the Microsoft Teams platform for delivering lessons. 2. Developed a formative assessment to measure the cognitive understanding of smart clothing.The research tools were applied to a sample of 33 students from the second year of the garment manufacturing specialization at Bani Mazar Secondary Technical School for the academic year 2023–2024. The findings revealed statistically significant differences at the level of (α ≤ 0.05) between the mean scores of the students in the pre- and post-tests for cognitive achievement and observation checklist, favoring the post-application results.

Keywords: Blended Learning – Smart Clothing – Industrial Technical Education

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Introduction:

The world is experiencing an information and knowledge revolution across all areas of life, especially in education. There is an urgent need for new educational approaches that provide interactive learning environments to engage learners. Consequently, many educators are seeking to blend traditional and online education to enhance the learning process. These modern technologies support education and open up vast avenues for creativity and development, gradually moving away from outdated methods that no longer suit the emerging generation. Concepts like flipped learning, e-learning, and blended learning, along with the growing importance of social media, have become vital communication channels **(Chaalal, 2, 2020)**. (**Medina, 2018, 42)** emphasizes that integrating e-learning with direct instruction ensures flexibility in accessing and utilizing knowledge while providing diverse social interaction styles tailored to different learning needs. Additionally, modern technology has advanced the clothing industry by replacing certain chemicals with enzymes to achieve enhanced chemical properties in specific garments **(Abdul Amir, 55, 2020).** The use of technology in producing specialized clothing is a key factor in meeting user demands and adding new benefits **(Hafiz, 2005, 2)**. Given these technological advancements in various fields, especially in electronics and materials engineering, high-tech wearable technology, or "smart clothing," has emerged as a significant concept of the 21st century **(El-Gamal, 2009, 1188)**.

First: Problem Statement:

Despite the widespread technological integration in various aspects of life, particularly education, there remains a deficiency in addressing vocational education curricula. While educators strive to utilize modern technologies and educational platforms, vocational education continues to rely heavily on traditional methods. The researcher identified this problem through several observations:

1. As a garment instructor, the researcher noted that the curricula for the ready-made clothing department still need to align with technological advancements.
2. Numerous studies emphasize the importance of blended learning and modern technologies, highlighting the need to leverage educational platforms to enhance and innovate the educational process (e.g., studies by Khalaf, (2021), Mohamed (2020), Al-Kandari, (2019), Ekici (2017), Tripathi (2016), and Al-Said (2015)).
3. Many vocational education teachers lack digital skills and the ability to engage with educational platforms, with only one study in this area (Al-Bitar, 2020) identified by the researcher.

4. Several studies confirm that vocational education curricula require ongoing development to keep pace with scientific and technological advancements and the labor market's demand for skilled workers with new scientific and technological concepts (e.g., studies by Rizq, (2019), Ali, (2013), Al-Najahi (2003), and Hindawi (2009).
5. Smart clothing is a recent topic in the textile manufacturing technology field, and the researcher believes it is essential to include this subject in the curriculum. Many studies highlight the significance of smart fibers and fabrics, which have revolutionized textile and ready-made clothing industries (e.g., studies by El-Gamal et al. (2009), Arafsha (2012), Hassan & Said (2018), Megled, (2016), and Al-Ani & Twaij (2017)).

Study Objectives:

1. Develop a blended learning program for teaching smart fabrics.
2. Evaluate the effectiveness of the proposed blended learning program in enhancing the knowledge and concepts contained in the unit for female students in industrial technical education.
3. Assess the effectiveness of the proposed blended learning program in developing practical skills among female students in industrial technical education.

Significance of the Study:

1. The research contributes by developing a blended learning program for teaching smart fabrics, a topic not currently included in the curricula for the ready-made clothing specialization.
2. The study highlights the importance of blended learning and its applicability in teaching various curricula in industrial technical education, particularly in ready-made clothing and textile departments.
3. It designs educational scenarios that integrate classroom and online instruction to enhance the learning experience.
4. It aims to replace traditional methods in teaching industrial technical education with approaches based on advanced technology.
5. This study will guide vocational education officials to reconsider curriculum design and development in line with technological advancements and innovations.

Second: Literature Review and Previous Studies:

First: Blended Learning:

Educators continuously seek the best methods and tools to create an engaging interactive learning environment that captures students' attention and encourages the exchange of ideas and experiences. Information technology, represented by computers and the internet along with multimedia communication tools, has proven effective in providing this educational environment **(Harvey, 2003, 52),** (**Cleveland, 2016, 132)** defines blended learning as an educational system that utilizes all available technological resources by combining multiple learning methods and tools, both electronic and traditional, to deliver high-quality learning tailored to learners' characteristics and needs. (**Al Rowais 2017, 151)** believes that blended learning is an effective integration pattern that connects traditional learning methods used in classrooms with electronic learning applications.

The researcher defines blended learning as a comprehensive educational model that links traditional classroom teaching with online education through educational platforms, aligning with the characteristics and needs of learners and achieving the desired goals of the learning process.

Characteristics of Blended Learning:

Both Al-Farsi (2021, 149), Youssef (2018, 21-22), Bahr, (2018, 22), and Al-Saud (2018, 28-31) agree that **blended learning is characterized by several features, including:**

1. **Communication and Guidance:** Interaction between the learner and the teacher, where the teacher guides the student on when to learn and clarifies the steps to follow and the programs to be used.
2. **Collaborative Teamwork**: Each participant (teacher and learner) recognizes that this type of learning requires interaction among all participants.
3. **Creativity and Innovation:** Encouraging students to engage in self-directed learning and group learning.
4. **Flexibility**: Blended learning allows students to access information and answer questions regardless of time and place.
5. **Connection**: Guiding and directing students, encouraging networking among students, sharing experiences, and solving problems (Youssef, 2018, 22).
6. **Social Interaction**: There should be a fast and always-available communication method between teachers and students for guidance and support, and networking among students should be encouraged (Youssef, 2018, 22).

7. **Integrated Content**: Educational content can be delivered in both electronic and printed formats (Bahr, 2018, 22-23).
8. **Assessment and Results Measurement**: Blended learning provides traditional and electronic assessment methods, allowing educators to classify and measure the extent to which learners acquire the presented information and concepts quickly and easily **(Dangwai, 2017, 133).**

Advantages of Blended Learning:

After reviewing various studies (Ghimire, B., 2022, 90) ;((Yousri, 2021, 15-16); (Farhat, 2021, 43-44); (Abdel Aziz, 2018, 25); (Ibn Madi, 2018, 206), (Youssef, 2018, 9-10); (Al Rowais, 2017, 157) (Al-Zayat, 2013, 189), (Ismael 2009, 98); (Hassan, 2006, 61) the researcher summarizes the advantages of blended learning as follows:

- ☒ Significantly reducing educational costs compared to solely electronic education.
- ☒ Empowering learners to express their opinions and ideas, and saving time for participation in class and seeking facts and information more effectively than in traditional classrooms.
- ☒ Allowing students to continue learning during emergencies, enabling them to access information whenever they need it while accommodating individual differences and improving the learning environment.
- ☒ Focusing on the active role of the student in acquiring knowledge through integrating collaborative activities.
- ☒ Providing an ongoing interactive environment between the student and the educator, clearly presenting the material through various applications accompanied by visuals and audio.
- ☒ Enhancing human aspects and social relationships among learners and between teachers and learners, allowing students to express their ideas.
- ☒ Sufficient flexibility to meet all individual needs and learning styles of learners, regardless of their levels and ages.

Models of Blended Learning Design:

Stefan (2019, 566-569) outlines four models of blended learning:

1. **The Rotation Model**: Students rotate among different learning modalities, including some distance learning, with other forms involving full classroom instruction or group projects.

2. **The Flex Model**: Content is delivered and accessed remotely, with students progressing based on a schedule, while instructors provide support as needed.
3. **The Self-Blend Model**: Students take one or more courses remotely to support and complement their usual curricula.
4. **The Enriched-Virtual Model**: Students divide their time between attending school or campus and learning remotely within specified limits and a prepared environment.

Studies Related to Blended Learning:

The results of numerous previous studies have confirmed the effectiveness and importance of using blended learning in teaching, including studies by: Abdel Hafeez,(2023), Suleiman, (2021), Hashem, (2021), Farhat, (2021), Al-Ajmi, (2018), Youssef (2018), Medina (2018), Al-Anzi (2017), Jou Lin and Wu (2016), and Kong (2014), as well as Al-Fuqai (2010).

Suleiman's Study (2021): This study proposed requirements for developing blended learning competencies for faculty members at the Faculty of Education, Damietta University. It relied on a descriptive approach to collect information, identifying key competencies necessary for faculty members to benefit from blended learning. A questionnaire was used as a research tool applied to a sample of 1,254 students from the Faculty of Education, Damietta University, and the study found that blended learning competencies (technical, administrative, and evaluative) were available at a moderate level, highlighting the need to develop these competencies.

Ismail's Study (2021): The study aimed to employ blended learning to develop some geographic visual culture skills among first-year preparatory students. The sample consisted of 40 students from Kafr Al-Tayefa Preparatory School, affiliated with Kafr Al-Sheikh Educational Administration. Research tools were applied in both pre- and post-tests, revealing a statistically significant difference at the 0.01 level between the mean scores of the experimental and control groups in geographic visual culture skills in favor of the experimental group.

Farhat's Study (2021): This study aimed to verify the effectiveness of an integrated electronic educational program for developing some ethical concepts in kindergarten children. The sample included 60 children from the Egypt Future Official Languages School, Waily Educational Administration. The sample was divided into an experimental group of 30 children and a control group of 30, aged between 5-6 years. The study employed a quasi-experimental design, and the results indicated the effectiveness of the integrated electronic educational program in developing some ethical concepts among kindergarten children.

Youssef's Study (2018): This study aimed to equip student teachers with skills in designing and producing electronic tests through an approach based on blended learning, integrating face-to-face teaching with an electronic program developed by the researcher. The study found a positive effect of the proposed strategy based on blended learning in equipping participants with skills for designing and producing electronic tests.

Al-Ajmi's Study (2018): This study aimed to verify the effect of blended learning design based on the Kemp model in developing the competencies of educational technology students at the College of Basic Education in Kuwait. The developmental method was used for both experimental and control groups, confirming the importance of blended learning in enhancing the competencies of educational technology students.

Jou Lin and Wu's Study (2016): This study examined the effect of a blended learning environment on critical thinking and cognitive transformation among students. It hypothesized that a blended learning environment, combined with cognitive transformation techniques, could create a learning environment conducive to developing analytical thinking and cognitive transformation. The study utilized a range of educational tools available online for students to share known and unknown information, indicating that the approach significantly supported educational motivation.

Yapici Study (2016): This study examined the effectiveness of a blended collaborative learning environment in teaching biology and its impact on the academic achievement of high school students and their satisfaction with the blended learning environment. The aim was to assess the effect of the blended collaborative learning environment (BCLE) on teaching biology. The study used both quantitative and qualitative research methods with two groups of students: 30 in the 2012-2013 academic year and 31 in the 2013-2014 academic year.

Kong's Study (2014): This study aimed to explore the experience of blended learning in teaching and learning a specific topic in primary school mathematics, relying on teacher-directed and student-centered teaching activities. A quasi-experimental design was employed, targeting teachers and students, with results showing that assessments indicated students could effectively acquire knowledge using the blended learning approach designed for the learning context.

Bersin's Study (2003): This study concluded that the best outcomes for blended learning programs occurred when combining more complex tools with simpler ones, such as an online course followed by hands-on activities in an interactive classroom. The study was applied to over 30 blended learning programs in institutions to understand its dimensions.

Second: Smart Clothing:

Both electronics experts and fashion designers agree that smart clothing represents the true future of human apparel across various types, especially with the rapid advancements in electronics and nanotechnology.

Al-Ghandour (2018, 18) describes smart fabrics as those capable of self-regulation without external influence, meaning they can provide warmth in cold conditions while also offering a counteracting thermal sensation, such as a cooling effect in hot weather.

Stoppa and Chiolerio (2014) define smart clothing as garments enhanced with electronic functions, containing components like LEDs or sensors that monitor and adapt to the surrounding environment to protect the wearer.

Mattile (2006, 434) defines smart fabrics as a blend of materials and electronics, resulting in fabrics with multiple capabilities, capable of functioning in broader fields. Smart fabrics have been labeled as such due to their ability to sense their surrounding conditions and respond rapidly to changes, (Ferial Saloum, 2018, p. 32; Iman El-Sayed, 2021, p. 682).

Features of Smart Clothing:

As defined by both **Mohamed Al-Jamal (2004**) and **Dawood (2019, 3)**:

1. Smart clothing has the ability to interact with the surrounding environment, including the human body itself, and generates value through the use of advanced technology by integrating clothing with electronic functions.
2. Smart clothing has a mixed nature that necessitates collaboration among various industrial entities, requiring interdisciplinary teams involving engineering, electronics, electricity, communications, medicine, and fashion design.
3. Smart clothing is capable of providing comfort and can instill feelings of joy and happiness during everyday activities. (Ahmed, 2010, p. 507; Hassan & Sayid, 2018, p. 305)

Classification of Smart Clothing:

Al-Jamal, (2009, p. 1189) classified smart clothing based on the degree of intelligence into:

1. **Passive Smart Textiles:** Materials and textiles that react only to stimuli from their surroundings, exhibiting passive interaction.

2. **Active Smart Textiles**: Materials that have moved beyond passive interaction to achieve a sufficient degree of positive interaction with their environment.

3. **Very Active Smart Textiles**: These textiles can sense various stimuli and respond appropriately, adapting themselves as required.

Materials and Fibers Used in Smart Textiles:

The researcher summarizes findings from **Rizk, (2013, 13-20)** and **Dawood, (2019, 42-52)**:

1. **Phase Changing Materials (PCM):** These materials regulate temperature by absorbing, storing, and releasing heat when needed, such as paraffin stored in capsules.
2. **Shape Memory Materials**: These materials can respond to external stimuli and revert to their original shape once the stimulus is removed, composed of nickel and titanium alloys.
3. **Thermoelectric Materials**: A special type of semiconductor that converts electrical energy into thermal energy and vice versa, changing size when exposed to heat.
4. **Chromic Materials**: These materials change color in response to external stimuli.

Applications of Smart Fabrics:

First: In Medical Textile Production:

1. **Coolmax for Mental Health**: This type of clothing is sensitive to thermal changes and allows airflow to cool the user.
2. **Vital Signs Monitoring Clothing**: Fabrics embedded with sensors to monitor heart rates and sweat levels to prevent sudden infant death syndrome. (Mohamed Al-Ghandour, 2018, 23).
3. **Color-Changing Children's Clothing**: British inventors created clothing that changes color with the wearer's body temperature, known as "Baby Glow," enabling parents to easily detect fever. (Manal Ahmed, 2010, 508).
4. **Antimicrobial Clothing (X-Static Nanosilver):** Nanoparticles of silver are added to clothing for their strong antibacterial and antifungal properties.
5. **Vitamin-Enriched Clothing**: Fabrics infused with vitamins (A, E, C) that activate upon contact with skin heat, facilitating absorption. (Mohamed Al-Ghandour, 2018, 23-25).
6. **Cooling Clothing for Patients**: Developed for patients with multiple sclerosis, a chronic disease affecting the central nervous system.
7. **Air-Conditioned Clothing**: A Japanese company created innovative fabrics that significantly improve comfort in high temperatures using one-fiftieth the energy of a small air conditioner. (Ahmed, 2010, 508).
8. **Men's Underwear for Radiation Protection**: German students designed underwear to reduce electromagnetic radiation from mobile devices,

potentially preventing male infertility. These garments are made from special fabrics and silver wires. (Al-Ghandour, 2018, 23-25).

Second: In Military Clothing (GTWM – Kevlar):

One of the significant military projects in smart clothing is the "Smart Shirt" under the U.S. Army system, which is a bulletproof suit that reduces the weight carried by soldiers in battle while monitoring their health.

Third: Fabrics for Generating Electricity:

The integration of electrical connections with textiles was first recorded in 1911 with gloves heated for pilots and train, car, and manual transport operators. (Colin Cork et al., 2013).

Smart Heating Textiles: These rely on new technology involving foam layers in the wet textile compound compatible with outer nylon and inner layers, absorbing cold water and expanding to close openings in areas such as hands, feet, and neck. **(Al-Ani, Al-Tawij, 2017, 14).**

A shape illustrating light-emitting clothing

Fourth: Light-Emitting Clothing: Lee, Y. (2006, 100-102)

Optical materials and devices, including nanofilms and optical fibers, have been used in the production of textiles and ready-made clothing not only for aesthetic performance but also to provide additional functionalities. Light-emitting films made from multiple layers, repeatedly isolated, can be used to coat the surface of the fabric.

Fifth: Sunlight-Changing Fabrics: A group of scientists has announced the production of thin fabrics for humans that can change color on demand.

Sixth: Fire-Resistant Clothing: Nomex: Smart protective suits have been manufactured to withstand temperatures up to 800 degrees Celsius. They can measure the surrounding temperature, as light-emitting devices have been embedded in the fabric of the suit to provide light signals indicating the presence of danger.

Image illustrating the concept of fire-resistant clothing

Seventh: Self-Cleaning Clothes: Two chemists from the University of Hong Kong developed a technique for producing fabrics that do not get dirty or wear out, and do not require a washing machine for cleaning; exposure to sunlight is sufficient to clean them. (Ahmed, 2010, 509)

Eighth: Internet-Receiving Fabrics: These fabrics are equipped with a WiFi receiver that continuously scans the surrounding area to detect nearby wireless networks and displays the signal strength of these networks via an integrated indicator.

Ninth: Smart Clothes for Fat Burning and Weight Loss: These garments are designed for quick weight loss, as they trick the body into lowering its temperature, prompting the body to adapt to this lower heat. (El-Ghandour, 27, 2018)

Fourth: Previous Studies Related to Smart Fabrics:

There are many studies and research indicating the importance of smart clothing and its revolutionary impact on the textile industry, such as: the study by (Al-Khalwani, 2020), (**Rizq**, 2019), (Siham Ahmed, 2018), (El-Ghandour, 2018), (Hassan, Said, 2018), (Megld, 2016), (El-Sharqawi, 2016), (Nihal Afifi, 2013), and (Jonna Hing Yee, Tsang, 2006).

The study by **Rizq, (2019)** aimed to identify the effectiveness of a developed textile materials curriculum in increasing the academic achievement of ready-made clothing students and developing their attitudes towards sustainable development. The study sample consisted of 32 second-year industrial students specializing in ready-made clothing, and teaching a unit on smart clothing proved effective in increasing the academic achievement of the study group.

Dawood's study (2019) aimed to identify the effectiveness of a proposed educational unit to develop the creative skills related to designing smart clothing. The study concluded that the proposed unit was effective and that the rate of unfamiliarity was greater than the rate of familiarity with smart fabrics, with more than half of the study sample being unaware of the term "smart fabrics" and its applications.

El-Ghandour's study (2018) aimed to use nanotechnology to enhance the functional performance of clothing by integrating garments with modern technologies, known as "wearable technology." The study found that using smart fabrics could provide significant solutions to challenges.

El Demerdash's study (2018) aimed to explore the aesthetics of LED (light-emitting diode) lighting in the design and illumination of smart women's clothing. The study presented designs for smart clothing that perform their illuminated smart functions according to the body's needs and environmental adaptation requirements.

The study by **Al-Ani and Twaig (2017)** aimed to explore the designs of smart fabrics and their application methods in interior design for sustainability. The study sample consisted of a set of designs for smart fabrics (curtains, furnishings, carpets, wall and floor coverings). The study emphasized the importance of the practical needs for smart fabric, whether for lighting or thermal improvement.

Megld, study (2016) aimed to conduct an experimental study using smart fibers to produce fabrics resistant to pressure sores. This was achieved by using Max

Fresh FX Cool fibers treated with antibacterial silver ions, a type of smart fiber that produced 16 fabric samples. The study revealed the best samples that achieved high moisture absorption and the highest quality across all properties.

Afifi's study (2013) indicated the use of modern smart textile technologies to enhance the functional performance of clothing. The study emphasized the importance of benefiting from the scientific revolution in clothing by innovating designs that meet human needs in terms of comfort, safety, and luxury, and provide solutions to some traditional clothing problems, enabling them to interact with the surrounding environment.

Arafsha's study (2012) aimed to explore and implement more smart tactile clothing designed to emotionally impact users, focusing on influencing the emotions of movie viewers. The tactile jacket was designed, and the study focused on six basic emotions: love, anger, sadness, fear. An online survey was conducted with 92 participants who provided feedback on their expectations for the emotional tactile jacket.

Jonna Hing Yee, Tsang's study (2006) aimed to design and develop electrical sensing devices for smart textiles and clothing, concluding the importance of using smart clothing due to its numerous characteristics.

Defining the Research Sample:

The primary research sample was chosen from the second-year technical students specializing in ready-made clothing at Bani Mazar Technical Secondary School for Girls, which is part of the Bani Mazar Educational Administration in Minya Governorate. This is one of the schools supervised by the researcher in her role as a clothing advisor in industrial technical education. A class (2-3) was randomly selected from three classes for the second year specializing in clothing, with the sample consisting of 33 students.

Study Variables:

The current study variables are as follows:

Independent Variable:

The blended learning program for teaching the proposed unit on smart fabrics.

Dependent Variables:

These include the development of professional competencies for technical education students through:

- Development of knowledge and information contained within the proposed program for teaching smart fabrics.
- Development of skills included in the proposed program for teaching smart fabrics.

Study Tools and Sources:

This study relied on the following tools (all prepared by the researcher):

Experimental Treatment Tool:

Design of a proposed program based on blended learning for teaching smart fabrics (designing new educational situations that combine classroom teaching and online teaching using the Microsoft Teams platform). Through this, lessons on the proposed smart fabrics program will be presented using a series of videos and presentations.

Measurement Tools:

- An achievement test to measure students' understanding of the information and knowledge related to the proposed program for teaching smart fabrics.
- An observation checklist to assess the skills included in the proposed program for teaching smart fabrics.

Procedural Steps for the Study:

The study follows the following procedures to verify the validity of the study's hypotheses:

1. Reviewing the literature and previous studies related to blended learning, educational platforms, and how they are used as non-traditional learning environments. Additionally, reviewing previous studies on the topic of smart clothing, its characteristics, and how it is manufactured, in order to identify the different verbal connotations of the concepts and knowledge that should be included in the proposed unit. This also includes reviewing previous studies related to professional competencies, to benefit from them in preparing the theoretical framework, experimental treatment material, and research tools.
2. The preparation of the first experimental treatment material involves designing a proposed program based on blended learning for teaching smart fabrics. This includes the design of new educational scenarios that combine classroom teaching with online instruction using the Microsoft Teams platform. Through this platform, lessons of the proposed program on smart fabrics will be delivered and presented as follows:

A. Organizing and building a proposed unit on smart clothing and its design in the form of a series of lessons, detailing the overall objectives of the program as well as the objectives of each individual lesson. This includes the activities within the lesson, the teaching methods used, and the assessment strategies employed.

B. Preparing the learner's guide for the proposed program on teaching smart fabrics, and surveying experts to ensure the appropriateness of activities, teaching methods, assessment techniques, educational tools, and learning resources, and their alignment with the teacher's guide. Suggested modifications should be made based on this feedback.

C. Preparing the teacher's guide for the proposed program based on blended learning for teaching smart fabrics, and surveying experts to ensure the suitability of activities, teaching methods, assessment techniques, educational tools, and learning resources, as well as application tools. Suggested modifications should be made based on this feedback.

3. Surveying experts' opinions on the proposed program for teaching smart fabrics, which includes (Student Guide - Teacher Guide), to ensure the scientific and linguistic accuracy of the content and the clarity of concepts, information, knowledge, and skills within the unit. This is to ensure educational effectiveness and application suitability.
4. Registering an account on the Microsoft Teams platform and setting up a virtual classroom. This involves using the platform's various tabs, making content available, and presenting it to learners in the appropriate manner after defining the principles for content delivery, such as teaching lessons via the platform.
5. Preparing the lessons to be delivered through the educational platform using PowerPoint to present the content in slide format, capturing the attention of the study sample students.
6. Designing a WhatsApp group for easy communication with the study sample students and for sending instructions and activities via the group.
7. Preparing the assessment tools, including: a summative test to measure students' knowledge acquisition related to the program, and an observation checklist to assess the skills included in the program.
8. Surveying experts' opinions on the various assessment tools (summative test, observation checklist for measuring included skills).
9. Making adjustments to the assessment tools (summative test, observation checklist) based on expert feedback.
10. Conducting a pilot test for the program to calculate the statistical constants of the evaluation tools (summative test, observation checklist) and to ensure the program's suitability for application, as well as verifying it is free from complications and errors.
11. Selecting the study sample randomly from second-year students in the technical secondary school, Ready-Made Garments section, at Bani Mazar Girls Technical Secondary School.
12. Conducting a pre-test for the study tools (summative test, observation checklist) on the study sample.
13. Conducting the main experiment for the study, which involves teaching the proposed blended learning program. This program combines traditional classroom teaching with online teaching through the Microsoft Teams platform, where lessons on the proposed smart fabrics program are presented.
14. Conducting a post-test for the study tools (summative test, observation checklist) on the study sample.
15. Recording grades and conducting appropriate statistical analysis to verify the validity of the study hypotheses. Extracting results, discussing, and interpreting them.
16. Providing recommendations and proposed research based on the study results.

Calculating the Statistical Constants for the Achievement Test:

Before starting the main research experiment, the test was administered to a pilot group consisting of 20 second-year technical secondary students, which is a separate group from the primary research sample. The test was graded, and scores were recorded in preparation for calculating the statistical constants.

A- Validity of the Achievement Test:

The validity of the test was calculated using two methods:

1. **Content Validity (Judgment Validity):**

The researcher relied on content validity to verify the test's accuracy by presenting the preliminary version of the test to a group of referees and educational experts in the field of curricula and teaching methods, as well as specialists in ready-made clothing, totaling 14 individuals.

Their feedback was sought to determine the appropriateness of the test as a measurement tool and to ensure the content validity of the test, considering the following aspects:

- The relevance of the questions to the intended objectives.
- The appropriateness of the language and wording of the questions.
- The suitability of the questions for the students' cognitive level.
- The extent to which the test includes measurements of higher-order thinking skills.
- The test's applicability.

The results were as follows: the relative weight and percentage of agreement among the referees regarding the appropriateness of the test items:

Arbitration clauses	Availability						Relative weight	Percentage
	Available to a large extent		Available to some extent		Not available			
	Iteration	%	Iteration	%	Iteration	%		
1. The appropriateness of the questions to the objectives to be achieved.	14	**100%**	-	-	-	-	42	**100%**
2- The appropriateness of the linguistic and verbal formulation of the questions.	14	**100%**	-	-	-	-	42	**100%**
3- The appropriateness of the questions for the mental level of students.	14	**100%**	-	-	-	-	42	**100%**
4- The extent to which the test includes measuring higher levels of thinking.	12	**86%**	2	14%	-	-	40	**95%**
5- The scientific integrity of the test questions.	13	**93%**	1	7%	-	-	41	**98%**
6- The validity of the test for application.	14	**100%**	-	-	-	-	42	**100%**

As for the referees' opinions regarding the test questions, the results were as follows:

Question No.	Iteration	%	Question No.	Iteration	%	Question No.	Iteration	%	Question No.	Iteration	%
1	13	93%	14	13	93%	27	14	100%	40	13	93%
2	14	100%	15	14	100%	28	13	93%	41	12	86%
3	14	100%	16	14	100%	29	13	93%	42	12	86%
4	14	100%	17	13	93%	30	13	93%	43	14	100%
5	14	100%	18	13	93%	31	13	93%	44	12	86%
6	13	93%	19	13	93%	32	13	93%	45	14	100%
7	12	86%	20	14	100%	33	14	100%	46	14	100%
8	12	86%	21	12	86%	34	13	93%	47	14	100%
9	14	100%	22	12	86%	35	13	93%	48	13	93%
10	13	93%	23	12	86%	36	12	86%	49	14	100%
11	14	100%	24	12	86%	37	13	93%	50	14	100%
12	12	86%	25	13	93%	38	13	93%			
13	13	93%	26	13	93%	39	12	86%			

The percentage of referees' opinions on the test questions (N = 14) shows that the percentage of the referees' opinions ranged between **(86%, 100%).** Thus, the majority of the referees reached a consensus confirming the validity and reliability of the test in measuring what it was designed for after making a series of modifications that included the following:

- Rephrasing some questions due to either lack of clarity or excessive length.
- Moving or replacing some items from their original positions due to their lack of relevance.

Dimension	Question No.	Dimension correlation coefficient	Correlation coefficient for the test as a whole	Dimension	Question No.	Dimension correlation coefficient	Correlation coefficient for the test as a whole	Dimension	Question No.	Dimension correlation coefficient	Correlation coefficient for the test as a whole
First: Remembering	1	*0.76	*0.721	Second: Understanding	5	*0.971	*0.976	Third: Application	6	*0.718	*0.777
	2	*0.868	*0.822		7	*0.898	*0.916		8	*0.714	*0.593
	3	*0.903	*0.886		9	*0.68	*0.662		12	*0.777	*0.787
	4	*0.818	*0.762		11	*0.721	*0.719		18	*0.873	*0.826
	15	*0.764	*0.795		14	*0.931	*0.934		29	*0.714	*0.647
	17	*0.663	*0.635		15	*0.808	*0.783		30	*0.656	*0.633
	19	*0.768	*0.744		21	*0.971	*0.976		33	*0.698	*0.713
	25	*0.408	*0.494		23	*0.685	*0.661		35	*0.583	*0.58
	26	*0.903	*0.874		28	*0.899	*0.876		37	*0.62	*0.643
	39	*0.689	*0.609		31	*0.8	*0.822		38	*0.732	*0.738
	44	*0.651	*0.586		32	*0.866	*0.868		40	*0.689	*0.575
	45	*0.357	**0.329		36	*0.833	*0.81		41	*0.62	**0.435
	49	*0.589	*0.604		46	*0.899	*0.876				
					47	*0.833	*0.84				
Fourth: Analysis	10	*0.8	*0.873	Fifth: Installation	24	*0.549	*0.407				
	13	*0.655	*0.596		27	*0.877	*0.744				
	20	*0.826	*0.84		42	*0.851	*0.55				

	22	*0.8	*0.742								
	34	*0.867	*0.744								
	43	*0.755	*0.755								
	50	*0.593	*0.52								

Calculating Internal Consistency Validit:

To ensure internal consistency validity, the correlation coefficient for each item with the overall dimension to which it belongs, as well as the total test score, was calculated using Pearson's formula for raw scores. The results were as follows:

The correlation coefficient between the score of each question and the dimension it belongs to, as well as the total score of the achievement test ** indicates that the correlation is significant at the 0.01 level **indicates that the correlation is significant at the 0.05 level

It is clear from the previous table that the correlation coefficients between each item and the overall dimension it belongs to, as well as the total test score, were significant at the 0.05 level, which confirms the validity of the test for measuring its intended purpose.

B: Test Reliability (Cronbach's Alpha Reliability):

The reliability of the tool refers to the consistency of the tool's scores and the stability of its results on the same sample across different administration times. The reliability of the test was calculated using the "Cronbach's Alpha" formula.

By applying this formula to obtain the reliability coefficients of the test, the following results were obtained:

The Cronbach's Alpha reliability coefficient for the achievement test is shown

Dimnsion	Number of ferries	Total variance of phrases total V2 k))	Total Variance V2	Alpha Coefficient
Remember	13	3.06	17.42	0.89
Understanding	15	3.77	40.17	0.97
Application	12	3.44	17.83	0.90
Analysis	7	1.66	6.68	0.88
Installation	3	0.76	1.31	0.64
Total	50	12.28	302.98	0.98

It is evident from the previous table that the alpha coefficients for the test dimensions ranged between (0.64 to 0.97), while the overall alpha value for the test was (0.98), indicating high reliability coefficients that confirm the stability of the test and its suitability for application on the main sample.

Statistical Measures for the Observation Checklist:

After making the necessary adjustments, the validity and reliability of the checklist were assessed to ensure its suitability for application:

First: Assessing the Validity of the Judges:

The researcher relied on the judges' validity to verify the accuracy of the scale by presenting it in its preliminary form to a group of 14 educational and clothing experts to provide feedback and ensure the following:

1. The appropriateness of the items for the level of necessary competencies.
2. The suitability of the language and wording of the checklist items.
3. The logical sequence of the steps for constructing the competency.
4. The applicability of the observation checklist.

The results were as follows:

The relative weight and percentage of agreement among the judges regarding the suitability of the test items (N = 14).

Arbitration clauses	Availability				Relative weight	Percentage
	Clear/Fit		Unclear/Invalid			
	Iteration	%	Iteration	%		
1- The extent to which the items are suitable for the level of performance of the necessary competencies.	7%	1	93%	13	. 26	96%
2- The appropriateness of the linguistic and verbal wording of the card items.	7%	1	93%	13	26	96%
3- The logical sequence of the steps of building the merit.	0%	0	100%	14	28	100%
4- The extent of scientific integrity of the steps of building merit.	0%	0	100%	14	28	100%
5- The validity of the observation card for the application.	0%	0	100%	14	28	100%

The percentage of judges' opinions regarding the suitability of the items and statements in the observation card ranged between (96% to 100%). The researcher accepted a threshold of (80%) of the judges' opinions, and thus the judges agreed on all statements and items in the card, with the judges' modifications limited to rephrasing some statements.

Second: Calculation of the Reliability of the Card:

To calculate the reliability of the observation card, the researcher used the agreement coefficient (Cooper):

The researcher applied the card to a sample of (5) students from the pilot study sample. This was done by having the researcher fill out the card herself while colleagues with similar expertise in the field conducted observations. The observation card was presented to them, and they were briefed on its content and how to apply it. Each observer worked independently of the other at equal time intervals, Starting and finishing the observations together. After completing this process, the agreement percentage between the three observations was calculated, as shown in the following table:

Agreement rates of the three observations regarding the statements in the observation card

Question No.	The first with the second	The first with the third	The second with the third	Question No.	The first with the second	The first with the third	The second with the third	Question No.	The first with the second	The first with the third	The second with the third
1	80%	80%	100%	20	100%	100%	100%	39	100%	100%	100%
2	80%	80%	100%	21	100%	100%	100%	40	80%	80%	100%
3	80%	80%	100%	22	100%	100%	100%	41	80%	80%	80%
4	100%	80%	80%	23	100%	100%	100%	42	80%	100%	80%
5	100%	100%	100%	24	100%	100%	100%	43	100%	80%	80%
6	100%	100%	100%	25	100%	100%	100%	44	80%	80%	100%
7	100%	100%	100%	26	100%	100%	100%	45	80%	80%	80%
8	100%	100%	100%	27	100%	100%	100%	46	60%	60%	60%
9	100%	100%	100%	28	100%	100%	100%	47	80%	80%	100%
10	100%	100%	100%	29	100%	100%	100%	48	80%	80%	80%
11	100%	100%	100%	30	100%	80%	80%	49	80%	100%	80%
12	100%	100%	100%	31	100%	80%	80%	50	80%	٪80	80%
13	100%	100%	100%	32	100%	80%	80%	51	80%	100%	80%
14	100%	100%	100%	33	80%	80%	80%	52	100%	100%	100%
15	100%	100%	100%	34	80%	100%	80%	53	100%	80%	80%
16	100%	100%	100%	35	80%	80%	80%	54	100%	100%	100%
17	100%	100%	100%	36	80%	80%	80%	55	100%	100%	100%
18	100%	100%	100%	37	100%	80%	80%				
19	100%	100%	100%	38	100%	100%	100%				

It is clear from the results of the previous table that the percentage of agreement among the three observations ranged between **(80% - 100%),** indicating a high level of agreement that confirms the reliability of the observation card, except for statement number (46), for which the agreement rate among the three observations was low.

Hypotheses of the Study:

The current study aims to verify the following hypotheses:

1. There is a statistically significant difference at the level ($\alpha \leq 0.05$) between the mean scores of the student sample in the pre-test and post-test of the cognitive achievement test in favor of the post-test.
2. There is a statistically significant difference at the level ($\alpha \leq 0.05$) between the mean scores of the student sample in the pre-test and post-test of the observation card in favor of the post-test.

Methodology of the Study:

The current study aims to verify the following hypotheses:

1. There is a statistically significant difference at the level ($\alpha \leq 0.05$) between the mean scores of the student sample in the pre-test and post-test of the cognitive achievement test in favor of the post-test.

2. There is a statistically significant difference at the level ($\alpha \leq 0.05$) between the mean scores of the student sample in the pre-test and post-test of the observation card in favor of the post-test.

Methodology of the Study: The current study follows:

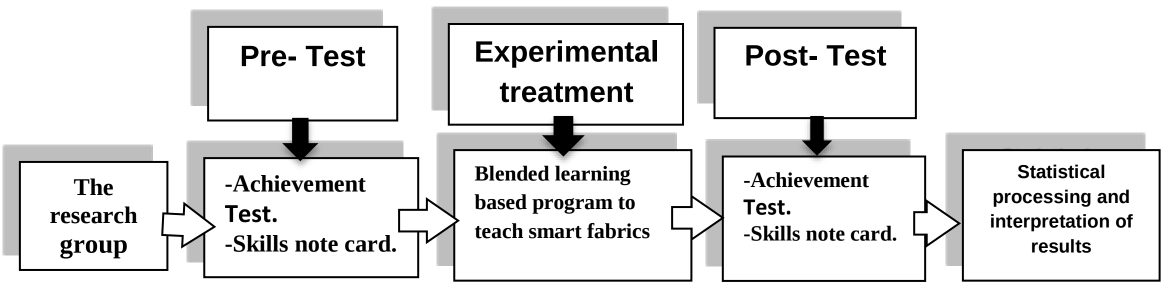
1. Descriptive Analytical Method: This is used for:

- Reviewing the literature and previous studies related to the topic of the study.
- Developing the proposed program for teaching smart textiles.
- Describing and analyzing results.

2. Quasi-Experimental Method: This is used during the implementation of the program, as the nature of the study aims to assess the effectiveness of the blended learning program for teaching the proposed unit on smart clothing to equip the student sample with professional competencies. This is done as follows:

- Pre-testing for both the cognitive achievement test and the observation card.
- Exposing the study sample to the experimental variable represented by the blended learning program for teaching smart textiles.
- Post-testing for both the cognitive achievement test and the observation card.

Based on the above, the experimental design used follows the one-group pre-test, post-test design, which can be represented as follows:



Experimental Design of the Study

Boundaries of the Study:

The current study is defined by the following boundaries:

1- **Objective Boundaries**: Developing a blended learning program for teaching smart textiles to students in vocational technical education.

2- **Human Boundaries:** The primary research sample was selected from second-year female students specializing in ready-made garments. A random selection of Class 2-3 was made from among three classes in the Beni Mazar Secondary Technical School for Girls, with a total of 33 students in the research sample.
3- **Spatial Boundaries:** The current study will be conducted at the Beni Mazar Secondary Technical School for Girls, affiliated with the Beni Mazar Educational Administration in Minya Governorate, Egypt. This school is one of those overseen by the researcher in her role as a clothing advisor in industrial technical education.
4- **Temporal Boundaries:** The program was implemented from March 17, 2024, to April 22, 2024, spanning over six weeks. This period included both pre-test and post-test applications of the measurement tools and the introduction of the program, as well as the execution of the program over 12 sessions.

Terminology of the Study:

- **Blended Learning**: For the purposes of this study, it is defined as a calculated scientific blend that combines elements of traditional classroom learning with components of e-learning through the use of an educational platform based on educational needs and surrounding conditions and capabilities.
- **Smart Clothes**: For the purposes of this study, smart clothes are defined as a study of everything related to smart garments, including their types, properties, importance, applications in the ready-made garment industry, and how they are produced.

First Hypothesis Testing:

The first hypothesis states, "There is a statistically significant difference at the level (α ≤ 0.05) between the mean scores of the study sample in the pre-test and post-test of the cognitive achievement test in favor of the post-test."

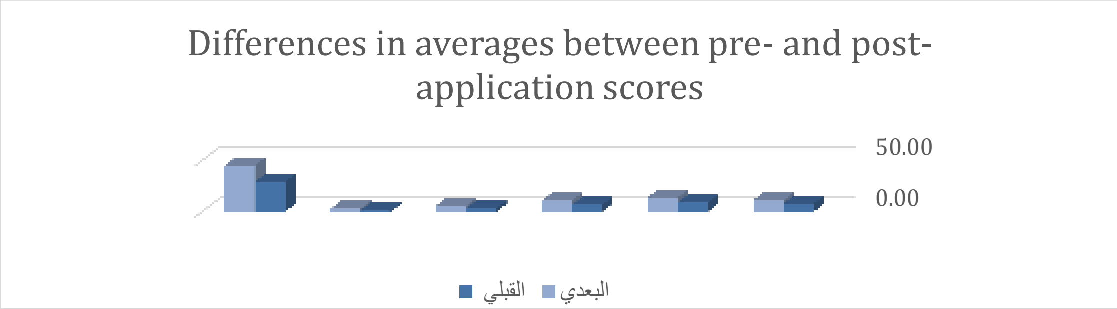
To verify this hypothesis, the test was applied to the experimental sample (n = 33) using the Paired-Sample T-Test. The results were as follows:

For the experimental group (pre−test – post−test) in the cognitive achievement test

Dimension	Sample	Arithmetic mean	Standard deviation	Degrees of freedom	Value of T	Significance level	Significance
Remember	Pre- Post t.	11,36 8.12	1.62 4.34	32	5.51	0.00	Significant
Understanding	Pre- Post t.	14.03 9.21	1.47 6.39	32	5.03	0.00	Significant
Application	Pre- Post t.	11.09 6.88	1.35 4.17	32	7.01	0.00	Significant
Analysis	Pre- Post t.	6.00 3.61	1.27 2.60	32	6.53	0.00	Significant
Installation	Pre- Post t.	2.76 1.39	0.56 1.14	32	7.22	0.00	Significant
Total	Pre- Post t.	45.24 29.21	4.78 17.61	32	6.58	0.00	Significant

The previous table shows that the calculated t-value for the total test axes was (8.63) and that the significance level is less than 0.05, indicating that there are differences between the pre-test and post-test applications in favor of the post-test. **Therefore, we accept the first hypothesis,** which states: "There is a statistically significant difference between the means of the experimental group scores in the pre-test and post-test in the health concepts test in favor of the post-test.

Regarding the individual axes, the t-test value also indicated statistically significant differences between the pre-test and post-test applications in favor of the post-test measurement, as it had the higher mean in all axes. The following illustrative figure shows the differences between the means.



Differences between the Means in the Pre-Test and Post-Test for the Experimental Group Calculating

Calculate the size of the effect:

To determine the effect size and the percentage improvement of the program on the post-test performance of the experimental group students in the overall test as well as its dimensions, the (d) equation was used, calculated using the following formula: The results were as follows:

Effect Size (d) Value for the Test

Dimension	Average Post- t.	Average Pre- t.	Standard deviation differences	Effect value(d)	Effectiveness size	Percentage improvement
Remember	11.36	8.12	3.38	0.96	Strong	40
Understanding	14.03	9.21	5.50	0.88	Strong	52
Application	1109	6.88	3.45	1.22	Strong	61
Analysis	6.00	3.61	2.11	1.14	Strong	66
Installation	2.76	1.39	1.08	1.26	Strong	98
Total	45.24	29.21	14.00	1.15	Strong	55

The previous table shows that the effect size (d) was (1.15) for the overall test, while it ranged from (0.96 to 1.26) regarding the three test dimensions. These values are greater than (0.25), indicating a high level of achievement for the research sample in the smart clothing unit studied through the proposed blended learning program in the post-test compared to the pre-test. This suggests an enhancement in the cognitive aspect of the smart fabrics unit.

Interpretation of the First Hypothesis Results:

The researcher believes that the acquisition of concepts and knowledge by the sample students in the proposed unit on smart clothing, which was taught using the blended learning-based program, as evidenced by the post-test compared to the pre-test, can be attributed to the following factors:

1. The scientific content of the blended learning-based program and the proposed educational unit was structured in a sequential, clear manner, free from complexities.
2. The clarity of the program's general objectives and the behavioral objectives within the unit, along with the variety of practical and procedural activities, allowed learners to gain a deeper understanding of the proposed unit.
3. The use of images and video clips contributed to the increased and faster knowledge acquisition by the study sample. Additionally, the diversity in assessment methods and the use of both immediate and conditional reinforcement strategies enhanced learner engagement and motivation for learning.

The results of this study align with previous research findings regarding the effectiveness of blended learning programs in improving academic achievement and motivation for learning, such Abdel Hafeez, (2023), Suleiman, (2021), Hashem, (2021), Medina (2018), Farhat, (2021), Bahr (2019), Al-Ajmi,(2018),Youssef (2018), Bahr (2019), and Jou, Lin, & Wu (2016), Jou Lin and Wu (2016), and Kong (2014), as well as Al-Fuqai (2010).

Testing the Validity of the Second Hypothesis: Testing the Validity of the Second Hypothesis:

2- There is a statistically significant difference at the level of ($\alpha \leq 0.05$) between the mean scores of the study sample in the pre-test and post-test for the observation checklist, favoring the post-test.

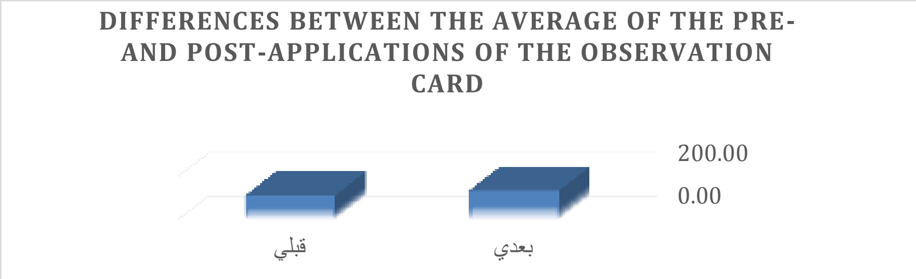
To verify this hypothesis, the test was applied to the experimental sample (where n = 33), and using the Paired Sample T-Test, the results were as follows

T-Test for the Experimental Group (Pre-Test – Post-Test) for the Observation Checklist

Tool	Sample	Arithmetic mean	Standard deviation	Degrees of freedom	Value of t	Significance level	Significance
Note card	Pre-Test Post-Test	135.09 112.8	17.58 19.44	32	11.56	0.00	Significance

It is evident from the previous table that the calculated T value for the total dimensions of the test reached (11.56) and that its significance level is less than 0.05, indicating that there are differences between the pre-test and post-test applications for the sample students in favor of the post-test.

Therefore, we accept the second hypothesis, which states: "**There is a statistically significant difference at the level of (α ≤ 0.05) between the mean scores of the study sample students in the pre-test and post-test for the observation checklist of professional competencies in favor of the post-test".**



Calculating the Effect Size: To determine the effect size and the percentage improvement of the observation process on the post-test performance of the study group students, the formula (d) was used. **The results are as follows:**

Value of the Effect Size (d) for the Observation Scale

Tool	Average Post- t.	Average Pre- t.	Standard deviation differences	Effect value(d)	Effectiveness size	Percentage improvement
Note card	135.09	112.48	11.24	2,01	strong	23%

It is clear from the previous table that the effect size (d) reached (2.01) for the observation scale, which is a value greater than (0.25). This indicates the development of the skill aspect among the student sample in the unit on smart clothing studied in the proposed program based on blended learning, as shown in the post-test compared to the pre-test. This demonstrates the enhancement of the skill aspect among the student sample in the unit on smart fabrics, benefiting from the experimental treatment, which confirms the effectiveness of the blended learning program in developing skills.

Analysis of the Results of the Second Hypothesis:

The superior performance of the female students (the study sample) in skill execution after using the program based on blended learning to teach the *Smart Clothing* unit—when comparing the pre- and post-application scores on the observation card—can be attributed to the program's role in developing and enhancing the students' professional competencies (skill component). This progress may be due to the following factors:

- **Integrating theoretical knowledge with practical application** in the program content.
- **Transitioning students from traditional learning to a hybrid approach** that combines conventional and e-learning, thereby increasing the enjoyment of learning.
- **Fostering practical competencies** (skill components) such as drafting basic patterns (corsage) and producing smart clothing.
- **Enhancing creative thinking, imagination, and problem-solving skills** among the students in the study sample.
- Encouraging **learning through trial and error**, fostering resilience and self-reflection.
- **Capturing students' attention** by engaging them with educational content delivered through the digital platform.
- Stimulating **curiosity and extending attention spans**, ensuring students remain engaged and focused.
- Increasing **excitement and motivation** while promoting a positive self-concept.

The results align with the effectiveness of blended learning programs in enhancing professional and practical competencies, as well as improving performance. This conclusion is consistent with previous studies, including: Rizq (2019), Ahmed (2018), Al-Ghandour (2018), Al-Ani & Tuwij (2017), Mujallad (2016), Al-Sharqawi (2016), Ibrahim (2015), Afifi (2013), Arafsha (2012), Hing Yee & Tsang (2006), and Al-Jammal (2009).

Research Recommendations:

In light of the results obtained from the current research, the following recommendations are suggested:

1. Utilize more blended learning programs and expand the use of educational platforms due to their effective impact on the learning process, especially for slow learners.
2. It is essential to draw the attention of those responsible for preparing vocational education curricula, especially in the ready-made clothing department, to align the curricula with modern technologies and manufacturing systems.
3. Emphasize the need to reconsider vocational education courses, particularly those related to ready-made clothing, and work on connecting theoretical knowledge with practical aspects to link school with work.

Proposed Research:

The current research suggests the possibility of conducting the following studies:

1. Developing other programs to enhance competencies and professional skills in subjects related to the ready-made clothing specialization.
2. Improving the technical and skill development of ready-made clothing teachers in accordance with modern industrial requirements and technological advancements.
3. Conducting similar research to the current study in other fields of vocational education.

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