IMPACT OF DIGITAL TEXTILE DESIGN IN LEVERAGING CAD AND CAM TECHNOLOGIES IN UNIVERSITIES IN ABIA STATE

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Abstract
This study explores the application of Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) technologies in digital textile design within universities in Abia State, Nigeria. Two research questions guided the study. Stratified random sampling technique was used to derive at 216 students and technical staff in Home Economics departments in Michael Okpara University of Agriculture, Umudike (MOUAU), and Abia State University (ASU) in Abia state. Questionnaire was used (online and hard copy) to get data and was analyzed using mean, standard deviation, while t-tests was used to identify significant differences and relationships among the variables majority of the respondents disagreed (D) to the current level of adoption and utilization of CAD and CAM technologies in digital textile design among home economics in Universities in Abia State it the mean score which ranges from 2.10 - 2.40 but agreed with the mean score of 3.94, 3.15, and 3.17 respectively that textile design program can incorporates CAM technologies in practical coursework also that CAD software can be integrated with CAM technology for efficient manufacturing processes and the adoption of CAD and CAM technologies in textile design program will improved their skills to be employable in the textile industry. Also, majority of the respondents agreed with the mean score ranging between 3.04 to 3.58 that CAD and CAM technologies can impact the use and quality of textile design among home economics in the employability of graduates. The study recommends that institutions and government should develop and implement targeted training programs and workshops to enhance the proficiency of both students and faculty in using CAD and CAM technologies. Institutions should encourage faculty to attend conferences, workshops, and other professional development opportunities to continuously improve their teaching methods and integrate new technological advancements into their curriculum. These steps will therefore be essential for equipping students with the skills necessary to thrive in a digitally-driven design environment.

Keywords: Abia State, CAD, CAM, Digital Textile Design, Universities

Introduction

Digital textile design has revolutionized the textile and fashion industries, offering innovative tools and techniques to create intricate and diverse patterns and designs. Digital textile design has seen a substantial transformation thanks to the incorporation of computer-aided design (CAD) and computer-aided manufacturing (CAM) technology, which have improved accuracy, productivity, and creativity over previous approaches (Hao, & Ni, 2022). One American firm makes CAD software. It is employed to boost a designer's productivity, enhance design quality, provide better collaboration through documentation, and build a database for production. Electronic files for printing, machining, or other industrial processes are frequently the result of CAD output. There is additional usage of the word CADD, which stands for Computer Aided Design and Drafting (Sadrehaghighi, 2022). With CAD, one may create solids, surfaces, and curves in three-dimensional (3D) space, as well as figures and curves in two-dimensional (2D) space. CAD is a significant industrial art that is widely employed in a wide range of applications, such as prosthetics, clothing and textile, automobile, shipbuilding, aerospace, and many more. However, in Nigeria and many other nations, Autodesk is the most widely used CAD program. For the majority of professionals working in the built environment, it is

highly significant (Oyebode, Adebayo, & Olowe, 2015). Making the most of these cutting-edge technologies is essential to ensuring that educational outputs meet business objectives and producing a competitive workforce, primarily in the digital textile sector.

Digital textile design involves the use of digital tools to create textile patterns and designs, which are then, produced using various printing and manufacturing techniques. CAD technology is essential to the design process because it makes it simple for designers to produce precise and detailed designs (Okoro and Chinwe 2019). On the other hand, CAM technology speeds up the manufacturing process and guarantees that the patterns are accurately printed on textiles. Together, these technologies allow for mass customisation, lower material waste, and improved quality and efficiency in textile production.

For a number of reasons, CAD and CAM technology integration at Abia State universities is crucial. First, educators use CAD and CAM technologies reasonably often. The benefits, which include increased creativity and efficiency, are widely acknowledged, but they are not fully employed because of a number of obstacles (Okoro and Chinwe 2019). Demirovic, Habibovic, Dzemidzic, Tiro, and Nakas (2019) discovered that the utilization of 3D computer-aided design (CAD) software resulted in the creation of more precise and lifelike depictions of textile products by designers. This, in turn, decreased the necessity for physical prototypes and minimized material waste. The adoption of these technologies allowed designers to produce more effective and resource-conscious designs, which in turn reduced the environmental impact of textile production, according to a different research by Rissanen and Gwilt (2012). It ensures that students obtain relevant skills that are in demand in the labor market by aligning the curriculum with current industry requirements. It also improves the learning experience by giving students practical exposure with cutting-edge equipment,

It encourages innovation and entrepreneurship among students, giving them the tools necessary to launch their own firms or make significant contributions to already-existing textile companies (Nguyen & Luong, 2018). This enhances their technical proficiency and inventiveness. Constructivism is the idea that underpins this, according to which learning is an active process in which people create their own knowledge and understanding via interactions with their surroundings and past experiences. According to constructivism theory, students learn best when they are actively involved in the design process and have the chance to put their knowledge and abilities to use in real-world, hands-on projects. This idea is especially relevant to textile design education. Since it allows students to actively participate in the design process and apply their knowledge and abilities in the development of digital textile designs, the use of CAD and CAM technology in textile design education is in line with constructivism's tenets. Institutions may provide an interactive, dynamic learning environment that supports the creation of knowledge and comprehension by giving students the chance to utilize CAD and CAM technology in their coursework.

The current state of digital textile design is characterized by rapid technological advancements and the increasing adoption of CAD and CAM technologies across the textile industry. The creation of advanced textile design software, such Adobe Textile Designer and CLO 3D, which provide large pattern and texture libraries and facilities for 3D visualization and simulation, is one of the major developments. Textile designers now have more options because to developments in digital printing technologies like dye-sublimation and inkjet printing, which enable high-quality, customisable designs on a variety of textiles (Ujiie, 2018). But one major obstacle to the successful integration of cutting-edge technology in educational settings is the lack of access to contemporary equipment (Ezugwu and Njoku 2020).

Despite the significant benefits of CAD and CAM technologies in digital textile design, their adoption in Universities in Abia State hampers the ability of these institutions to provide cutting-edge education and training to students in courses that incorporate CAD and CAM technologies., ultimately affecting the competitiveness of graduates in the job market. This is because many institutions find it challenging to the integration of CAD and CAM technologies into existing textile design curricula due to the fact that they are struggling to attract and retain staffs with the necessary skills and knowledge to integrate technologies into their teaching practices. Another challenge is the lack of trained faculty and staff who are proficient in the use of CAD and CAM technologies in textile design. Additionally, there are lack of professional development opportunities for existing faculty members to improve their skills and knowledge in this area. Furthermore, the lack of adequate infrastructure and resources to support the integration of these technologies poses a significant challenge. Consequently, there is a pressing need to address these issues to enhance the quality of programs and ensure that they meet the evolving demands of the textile industry in home economics.

Thus the significant of this study will contribute to the existing body of knowledge on the use of CAD and CAM technologies in textile design education, particularly in the context of institutions in Abia State. The findings of this study may be useful for other institutions in Nigeria and beyond that are seeking to integrate these technologies into their textile design curricula. Second, this study will provide valuable insights for policymakers and stakeholders in the sector on the challenges and limitations associated with the implementation of CAD and CAM technologies in textile design education. This information may be useful for informing policy decisions and resource allocation related to the provision of hardware, software, and professional development opportunities for faculty members in this area. Finally, this study will have important implications for the employability of students in the fashion and apparel industry. By effectively integrating CAD and CAM technologies into textile design curricula, institutions can ensure that students are equipped with the necessary skills and knowledge to succeed in the industry. This, in turn, may lead to improved employment outcomes for graduates and contribute to the overall competitiveness of the fashion and apparel industry in Abia State and beyond.

Purpose of the Study

The general purpose of the study is to examine the impact of digital textile design in leveraging CAD and CAM technologies in universities in Abia State. The specific objectives are to ascertain:

1. To evaluate the current level of adoption and utilization of CAD and CAM technologies in digital textile design among home economics in Universities in Abia State
2. To assess the impact of CAD and CAM technologies on the quality of textile design among home economics in the employability of graduates

Research Questions

3. What is the current level of adoption and utilization of CAD and CAM technologies in digital textile design among home economics in Universities in Enugu State?
4. How do CAD and CAM technologies impact the use and quality of textile design among home economics in the employability of graduates?

Hypotheses

The following null hypotheses are formulated and tested at a 0.05 level of significance;

$H0_1$: There is no significant difference between the mean rating scores of Federal and State Universities that have adopted CAD and CAM technologies.

$H0_2$: There is no significant difference between the mean responses of Federal and State Universities in the employability of graduates from digital textile design that utilize CAD and CAM technologies.

Methodology

The study employs a descriptive survey research design to investigate the integration and impact of Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) technologies in digital textile design within Technical and Vocational Education and Training (TVET) at federal universities in Abia State, Nigeria. Descriptive survey design is chosen because it allows for the systematic collection and analysis of data to describe the current status and relationships among variables without manipulating the study environment (Creswell, 2014). This approach is effective for understanding the extent of CAD and CAM technology adoption, the challenges faced, and the benefits observed in digital textile design education.

The area of the study is Abia State, located in the southeastern part of Nigeria. Abia State is known for its significant contributions to Nigeria's textile and garment industry, with major cities like Aba being renowned for their vibrant textile market (Ekpo & Ukpong, 2014). The choice of Abia State is justified due to its strategic importance in the textile industry and the presence of universities that offer clothing and textile programs. These institutions are pivotal in shaping the skills and competencies of future professionals in the textile sector.

The population for this study comprises all technical staff and students involved in digital textile design programs within the clothing and textile departments of universities in Abia State. Specifically, the study focuses on Michael Okpara University of Agriculture, Umudike (MOUAU), and Abia State University (ASU). The inclusion of technical staff is essential as they play a critical role in implementing and facilitating the use of CAD and CAM technologies, while students represent the primary beneficiaries of these educational advancements.

A stratified random sampling technique is employed to ensure representative participation from various sub-groups within the population, including technical staff and students. Stratification is based on roles (technical) and academic levels (undergraduate vs. postgraduate students). A sample size of 216 respondents is selected, comprising, 50 technical staff, and 166 students. Stratified random sampling is chosen

to enhance the accuracy and generalizability of the findings by ensuring that all relevant sub-groups are proportionately represented (Fraenkel, Wallen, & Hyun, 2012).

The primary instrument for data collection is a structured questionnaire designed to capture quantitative data on the use of CAD and CAM technologies in digital textile design. A Likert scale is used to measure respondents' perceptions and experiences. The questionnaire is supplemented formulated base of the content of the work

To ensure the reliability of the questionnaire, a pilot test is conducted with a small sample (20 respondents) among Home Science students in the University of Nigeria which is different but similar institution. Cronbach's alpha is calculated to determine the internal consistency of the instrument, with a threshold of 0.7 set for acceptable reliability (Tavakol & Dennick, 2011). Necessary adjustments are made based on the pilot test results to enhance the clarity and effectiveness of the questionnaire items.

The questionnaires were distributed both electronically and in hard copy to accommodate respondents' preferences and ensure higher response rates. The data collection process spans four /weeks for the electronic, and on spot collection was done on the hard copy distributed allowing sufficient time for respondents to provide thoughtful and comprehensive answers.

The items in the questionnaires were analyzed using mean, standard deviation, while t-tests was used to identify significant differences and relationships among the variables. Statistical analysis is performed using SPSS software, ensuring robustness and reliability of the findings.

Findings

Research Question 1: What is the current level of adoption and utilization of CAD and CAM technologies in digital textile design among home economics in Universities in Abia State?

Table 1: Mean and standard deviation of the current level of adoption and utilization of CAD and CAM technologies in digital textile design among home economics in Universities in Abia State.

N= 216

S/N	Item Statement	Mean	SD	Dec
1	CAD technology is integrated into our digital textile design curriculum	2.22	.730	D
2	I have received adequate training on CAD software for digital textile design	2.10	.759	D
3	I am familiar with the CAD software used in digital textile design	2.40	.808	D
4	Staffs are well-trained in utilizing CAD technologies for textile design	2.34	.826	D
5	Textile design program incorporates CAM technologies in practical coursework	3.94	1.050	A
6	CAD software is integrated with CAM technology for efficient manufacturing processes.	3.15	.961	A
7	There are plans to invest more in CAD software and training in home economics in the future	2.40	.788	D
8	There is comprehensive training on both CAD and CAM technologies before graduation	2.32	1.076	D
9	The adoption of CAD and CAM technologies in textile design program will improved my skills to be employable in the textile industry	3.17	.842	A

NB: N= Number of respondents; SD= Standard Deviation; Dec.= Decision; A= Agreed; D= Disagreed

Result on Table 1 shows the mean and standard deviations of 9 items on the current level of adoption and utilization of CAD and CAM technologies in digital textile design among home economics in Universities in Abia State. It table shows that the respondents disagreed that CAD technology is integrated into their digital textile design curriculum, they have not received adequate training on CAD software for digital textile design also they are not familiar with the CAD software used in digital textile design. They also disagreed that staffs are not well-trained in utilizing CAD technologies for textile design while there is no plans to invest more in CAD software and training in home economics in the future with no comprehensive training on both CAD and CAM technologies before graduation with the mean rating within 2.10 - 2.40 which indicates disagreed (D). This means that the current level of adoption and utilization of CAD and CAM technologies in digital textile design as outlined in the items were disagreed. In addition, the respondents agreed with the mean score of 3.94, 3.15, and 3.17 respectively that textile design program can incorporates CAM technologies in practical coursework also that CAD software can be integrated with CAM technology for efficient manufacturing processes and the adoption of CAD and CAM technologies in textile design program will improved their skills to be employable in the textile industry.

Hypothesis 1: There is no significant difference between the mean rating scores of Federal and State Universities that have adopted CAD and CAM technologies.

Table 2: Independent sampled t-test analysis of the difference between the mean responses of Federal and State Universities that have adopted CAD and CAM technologies.

Institutions	N	Mean	SD	Df	t-	Sig (2-tailed)	Dec.
Federal	104	3.06	.431	214	-2.695	0.007	**S**
State	112	3.12	.275				

NB: N= Number of respondents; SD= Standard Deviation; df= Degree of freedom; Sig (2-tailed) = Probability value; t- = t-test value; S = Significant

The result on Table 2 shows the independent sampled t-test analysis of the difference between the mean responses of Federal and State Universities that have adopted CAD and CAM technologies. The result also shows that the probability associated with the calculated t (-2.695) for the difference in the mean ratings of Federal and State Universities that have adopted CAD and CAM technologies is 0.007. Since the probability value of 0.007 is less than the 0.05 level of significance, the null hypothesis was not accepted. This implies that there is a significant difference between the mean rating scores of Federal and State Universities that have adopted CAD and CAM technologies.

Research Question 2: How do CAD and CAM technologies impact the use and quality of textile design among home economics in the employability of graduates?

Table 3: Mean and standard deviations of the impact of CAD and CAM technologies on the quality of textile design the employability of graduates from these programs

N= 216

S/N	Item Statement	Mean	S.D	Dec
10	CAD and CAM technologies is a core component of textile design curriculum	2.26	.998	D
11	The integration of CAD and CAM technologies in textile design curriculum will enhances the overall quality of students	3.31	.903	A
12	Graduates from textile design program with CAD and CAM skills in home economics are more competitive in the job market	3.06	.926	A

13	There are adequate resources (software, hardware, training) for effective CAD and CAM integration in textile design education in home economics	1.17	.971	D
14	Exposure to CAD and CAM technologies keeps students updated with the latest trends and innovations in textile design	3.04	.935	A
15	Employers in the textile industry prefer hiring graduates who are proficient in CAD and CAM technologies.	3.58	1.037	A
16	CAD and CAM technologies makes graduates more relevant to current industry standards and practices	3.42	1.001	A
17	The use of CAD and CAM tools encourages greater creativity and innovation in textile design.	3.04	.185	A
18	Learning CAD and CAM technologies significantly improves students' technical skills in textile design	3.17	.215	A

NB: N= Number of respondents; SD= Standard Deviation; Dec.= Decision; A= Agreed; D= Disagreed

Result on Table 3 shows that the mean ratings of the impact of CAD and CAM technologies on the quality of textile design the employability of graduates from these programs. Out of the nine items, majority of the respondents agreed with the mean score ranging between 3.04 to 3.58 that the integration of CAD and CAM technologies in textile design curriculum will enhances their overall quality of students and graduates from textile design program with CAD and CAM skills in home economics are more competitive in the job market with exposure to CAD and CAM technologies which will keeps students updated with the latest trends and innovations in textile design. Furthermore, employers in the textile industry prefer hiring graduates who are proficient in CAD and CAM technologies and makes graduates more relevant to current industry standards and practices due to the use of CAD and CAM tools and the learning of CAD and CAM technologies will significantly improves students' technical skills in textile design. But disagreed that CAD and CAM technologies is a core component of textile design curriculum and there are no adequate resources (software, hardware, training) for effective CAD and CAM integration in textile design education in home economics with the mean score of 2.26 and 1.17 respectively.

Hypothesis 2: There is no significant difference between the mean responses of Federal and State Universities in the employability of graduates from digital textile design that utilize CAD and CAM technologies.

Table 4: Independent sampled t-test analysis of the difference between the mean responses of Federal and State Universities in the employability of graduates from digital textile design that utilize CAD and CAM technologies.

Institutions	N	Mean	SD	df	t-	Sig (2-tailed)	Dec.
Federal	104	3.18	.397	214	4.335	0.000	**S**
State	112	2.26	.603				

NB: N= Number of respondents; SD= Standard Deviation; df= Degree of freedom; Sig(2-tailed) = Probability value; t- = t-test value

The result on Table 4 shows the independent sampled t-test analysis of Federal and State Universities in the employability of graduates from digital textile design that utilize CAD and CAM technologies. The result reveals the probability associated with the calculated t (4.335) for the difference in the mean of Federal and State Universities in the employability of graduates from digital textile design that utilize CAD and CAM technologies is 0.000. Since the probability value of 0.000 is less than the 0.05 level of significance, the null hypothesis was not upheld. This implies that there is a significant difference between the mean rating scores of Federal and State Universities in the employability of graduates from

digital textile design that utilize CAD and CAM technologies.

Discussion

On table 1 and hypotheses on table 2 the respondents agree on that The Home Economics departments have very limited access to CAD and CAM tools and equipment. The development of skills and practical application are hampered by this lack. This is consistent with the findings of Okoro and Chinwe (2019), who noted that although educators are generally aware of CAD and CAM technologies, their use of them is limited despite the technologies' apparent advantages—such as increased efficiency and creativity. Furthermore, Ezugwu and Njoku (2020) discovered that a major obstacle to the successful integration of cutting-edge technology in educational settings is restricted access to contemporary equipment. According to Adeyemi et al. (2018), underutilization of accessible technologies is caused by inadequate training for both staff and students in home economics education. Thus, confirm results in Abia State, where a deficiency of knowledge and practical experience is common. Many faculty members are not well-versed in CAD and CAM technology, which makes it difficult for them to properly mentor and instruct students in these fields. The lack of training and practical experience among students is probably the reason for their lack of proficiency with CAD and CAM technology. Frequent interruptions and limited usefulness result from a lack of technical help for CAD and CAM system maintenance and troubleshooting. According to a study by Adebisi (2017), several Nigerian colleges only partially integrate CAD and CAM into their textile design curricula. The study emphasizes the need for comprehensive curriculum reform to include practical applications of these technologies and Olaleye and Akinlabi (2021) indicate that technical and financial support are critical to the successful adoption of CAD and CAM technologies. The lack of these supports in Abia State universities aligns with broader trends observed across Nigerian higher education institutions.

On Table 3 and hypotheses on Table 4 the respondents agree on the use of computer-aided design (CAD) and computer-aided manufacturing (CAM) technology has greatly improved textile design's accuracy and originality. Designers may now produce elaborate and sophisticated designs that would be challenging to accomplish by hand thanks to these technologies. According to research, the use of CAD/CAM in textile design increases design correctness and fosters more creative thinking (De Klerk & Tselepis, 2007). The design process for textiles is streamlined, made more efficient, and takes less time from concept to manufacturing when CAD and CAM are used. According to Hodge et al. (2005), CAD/CAM systems may cut the design cycle time by as much as 50%, which boosts productivity and enables designers to react to market changes faster. Additionally, these technologies enable bulk customisation, which enables designers to modify items to meet the demands of particular clients without incurring appreciable additional costs. Given the fast changes in customer tastes and trends in the textile sector, this capacity is very significant. Because they can use CAD and CAM technologies to increase design quality and efficiency, graduates with these skills are therefore more desirable to companies. Research has shown that graduates proficient in these technologies may fetch higher incomes and have improved career chances (Fletcher & Grose, 2012). Thus, graduates with skills in these areas are well-prepared to work in advanced manufacturing environments.

Conclusion

The use of CAD and CAM technologies in textile design has the potential to revolutionize the way that textile design education is delivered in universities in Abia State. By incorporating these technologies into curriculum, educators can guarantee that students have the abilities and information needed to thrive in the fashion and clothing sectors. Nevertheless, there are several difficulties and restrictions associated with using CAD and CAM technology in textile design education. Access to hardware and software, hiring qualified academics and staff, and incorporating these technologies into current courses are some of the challenges that universities in Abia State may encounter. The purpose of this study is to develop strategies and recommendations for successfully integrating CAD and CAM technologies into textile design curricula, as well as to provide a thorough assessment of the current state of digital textile design education in Abia State universities. By doing so, this study has the potential to contribute to the improvement of textile design education in universities in Abia State, and to enhance the employability and success of students in the fashion and apparel industry.

Recommendations

1. Institutions and the government should create and execute focused seminars and training programs to improve teacher and student competency with CAD and CAM technology.

2. In order to maintain technology current and relevant, institutions should work with industry partners. This will improve graduates' employability by equipping them with real-world experience and industry-standard abilities.
3. In order to provide students real-world experience in digital textile design, educational institutions have to support their faculty members in integrating industry-based projects into the curriculum.
4. To consistently enhance their teaching strategies and incorporate new technology breakthroughs into their curricula, institutions should encourage their faculty members to participate in conferences, workshops, and other professional development activities.

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