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Effectiveness of an educational Guidebook for Learning Digital Skills in Drawing Flat Patterns

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ABSTRACT

Integrating computer-aided pattern drawing into fashion design curricula has become an educational necessity amid the digital transformation of the fashion industry, as digital tools support both technical proficiency and self-directed learning. However, implementation faces challenges, chief among them the need to systematically train students in specialized software. This study addressed that need by designing a guidebook to improve the efficiency, accuracy, and skill of pattern drawing using Adobe Illustrator, then evaluating its effectiveness. The research aligns with Saudi Arabia's Vision 2030, particularly its Human Capability Development Program, by supporting digital design education and modernizing e-learning methods.

The study employed a single-group, pre-test/post-test design, applying Lesson 5 of the guidebook with 60 female students enrolled in the Computer-Aided Pattern Drawing course (DAFD 323). Results showed highly positive specialist evaluations of the guidebook's suitability, statistically significant gains in students' cognitive achievement and skill performance from pre-test to post-test, and effectiveness ratios confirming the guidebook met established benchmarks for instructional impact. Students also reported strongly positive attitudes toward the guidebook.

The researchers recommend adopting the guidebook within the course, developing similar guidebooks for other courses, and testing the guidebook against a comparison group in future research to isolate its specific contribution to these gains.

Keywords: Guidebook design, computer-aided pattern drawing, digital skills, digital education.

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Introduction

The contemporary world is witnessing rapid progress in digital technology, and this transformation has reshaped the fashion industry's product development processes, including pattern making. Integrating computer-aided pattern drawing (CAD) into fashion design curricula has therefore become an educational necessity, as graduates are increasingly expected to master not only the traditional principles of pattern making but also the digital software tools demanded by the contemporary job market. This includes competence in pattern creation, modification, grading, interlocking, file export, and understanding the relationship between digital patterns and 3D simulations (Zhu, 2023).

Beyond technical competence, digital pattern-making education also supports self-directed and collaborative learning: students can share files, discuss modifications, analyze errors, and present improved versions of their designs. Digital learning environments have expanded opportunities for teaching CAD skills in apparel education, whether delivered in person or remotely, particularly when learning tasks require producing patterns to strict specifications and analyzing outcomes against them (De Silva & Peramunugamage, 2023).

A growing body of research points to the educational and industrial benefits of digital pattern-making tools. Mohi Ud Din and Hussain (2025), for instance, report that digital tools can improve design accuracy, reduce human error, and shorten production cycles — benefits that also carry implications for the sustainability of fashion production. From an educational standpoint, Maatoug (2026) suggests that computer-aided pattern drawing helps students grasp the relationship between the flat pattern and the finished three-dimensional garment, strengthening both their visual and technical understanding of the pattern-making process. While these findings are promising, they remain drawn from a limited number of individual studies, and further research is needed to establish how consistently these benefits generalize across different educational contexts.

Despite these advantages, implementing computer-aided pattern drawing in the classroom is not without challenges. Chief among them is the need to systematically train faculty, technicians, and students in the use of specialized software. Importantly, the shift from manual to digital pattern drawing does not eliminate the need for foundational pattern-making knowledge — if anything, it demands a deeper understanding of the relationship between measurement, construction, and adjustment, since software is only an implementation tool and cannot compensate for gaps in underlying technical knowledge. Success in teaching computer-aided pattern making therefore depends on integrating manual foundations and geometric understanding with digital proficiency and industrial application (Widowati et al., 2024).

This shift is closely tied to the broader digital transformation underway in both higher education and the fashion industry. As modern fashion production increasingly relies on virtual product development, digital modeling, 3D simulation, and electronic communication across design, production, and marketing teams, printed instructional materials alone are no longer sufficient. Flexible, regularly updatable electronic

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guidebooks — compatible with current software and aligned with job-market demands — have become essential (Conlon, 2024). Effective instructional design in this context relies on interactive teaching methodologies that support cognitive achievement and skill performance in an engaging way, contributing to tangible learning outcomes (Wazzan, 2025). One particular strength of electronic guidebooks is their repeatability: they allow students to revisit instructional steps as needed, without depending exclusively on direct, real-time interaction with an instructor (De Silva & Peramunugamage, 2023).

This literature underscores the importance of developing a guidebook that provides comprehensive, well-organized educational and practical content to support skill development in applied fields such as fashion design and computer-aided pattern drawing. Such a guidebook functions as an organizational tool, helping learners perform tasks systematically by breaking procedures into clear, explained steps — thereby supporting a more efficient and scientifically grounded understanding of the pattern-making process. However, despite this recognized need, the literature reviewed here points primarily to the general value of digital guidebooks and CAD instruction, rather than to specific, tested examples tailored to teaching computer-aided pattern drawing at the undergraduate level. This gap forms the starting point for the present study.

In line with this gap, the research pursues three objectives: to design a guidebook that improves the efficiency, accuracy, and skill of pattern drawing using Adobe Illustrator; to measure the effectiveness of applying Lesson 5 of the proposed guidebook in learning computer-aided pattern drawing; and to assess students' attitudes toward the guidebook in developing their computer-aided pattern drawing skills.

The significance of this research lies in its alignment with the Kingdom of Saudi Arabia's Vision 2030, particularly its Human Capability Development Program, which aims to equip citizens with the skills needed to compete globally in a rapidly evolving labor market (Vision 2030, n.d.). Within this framework, the present study contributes by improving the quality of education in the field of digital design and increasing students' efficiency; continuously developing e-learning methods and modernizing concepts, content, and teaching approaches through the use of computers in education; and raising the skill level of fashion design students by developing their competence in using specialized software.

Research Problem

As shown in the literature reviewed above, while the value of digital tools and guidebooks in fashion education is well established in general terms, a review of the current educational landscape reveals a lack of simplified, tested educational guidebooks that systematically and methodically support learners in acquiring computer-aided pattern making skills specifically. This deficiency hinders the delivery of clear and organized practical steps necessary for digital learning, leading to varying levels of skill acquisition among learners and limiting faculty members' ability to effectively guide the educational process.

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Therefore, there is an urgent need to develop a comprehensive guidebook that highlights the steps for using digital software, enhances educational performance, improves the quality of learning outcomes, and provides a reliable, standardized framework for training learners in computer-aided pattern drawing in a structured and efficient manner. Accordingly, the research problem is formulated in the following main question:

To what extent is it possible to develop a guidebook for learning digital skills in flat pattern drawing?

This question branches into the following sub-questions:

1. What are the opinions of specialists regarding the suitability of the proposed guidebook for teaching a computer-aided pattern drawing course?
2. How effective is the application of the guidebook in developing computer-aided pattern drawing skills?
3. What are the students' attitudes toward using the guidebook in developing computer-aided pattern drawing skills?

Theoretical Framework

This section reviews the literature related to computer-aided pattern drawing in fashion design education, including relevant guidebooks and digital learning resources, in order to situate the present study within existing scholarship and to clarify the gap it addresses.

Digital Pattern Drawing

Pattern drawing is a pivotal stage in the garment industry and fashion design, serving as the link between an abstract design concept and the finished garment. A design can transform from an artistic sketch or visual concept into a wearable product only through the creation of a precise pattern that translates body proportions, design lines, fabric properties, and movement and comfort requirements into flat pieces that can be cut and sewn. For many years, pattern drawing relied primarily on manual skill and accumulated experience; however, the broader digital transformation of the fashion industry has led to the emergence of specialized computer systems for drafting, modifying, grading, and virtually simulating patterns (Lei & Li, 2022).

Computer-aided pattern drawing refers to the use of computer-aided design software to create flat garment models — whether by drafting the basic pattern, modifying its lines, adding design details, performing grading operations, interlocking, or linking the pattern to a 3D simulation to test fit and shape before physical prototyping. Zhu (2023) argues that CAD techniques in pattern drawing have moved beyond being a merely auxiliary technical skill to become an essential part of garment product development, owing to their accuracy, speed, flexibility in modification, and integration with digital production systems.

This shift is reflected in the growing use of digital pattern drawing and simulation software — such as CLO3D, Richpeace, Gerber, and Optitex — in vocational education and training, where such tools support model building, modification, and simulation of materials and garment fit prior to manufacturing. However, simply

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making these programs available in computer laboratories does not guarantee effective learning; clear, structured educational materials are needed to help students understand both the basic and advanced functions of the software. In this sense, an e-guidebook serves as a bridge between the software's technical capabilities and the learner's ability to use them effectively (Istituto Marangoni, 2026).

Designing such a guidebook also requires treating pattern drawing as a cumulative skill rather than a set of isolated tasks. Rather than beginning with complex operations, instruction should progress from the program interface and basic drawing tools, through drafting the basic pattern and adding seams, to grading and, finally, interlocking or simulation. Widowati et al. (2024) further emphasize that a guidebook should incorporate diverse practice models so that students learn to apply underlying principles across different designs, rather than practicing a single fixed model — positioning the guidebook as a tool for building conceptual understanding rather than merely describing fixed steps.

Pattern-Making Guidebooks and Their Role in Teaching Pattern Drawing

An electronic pattern-drawing guidebook in fashion education can be defined as a digital educational resource that guides students step-by-step through acquiring a skill or completing a specific design task, accessible via computers, tablets, smartphones, or e-learning platforms. Unlike printed guidebooks, this format is not limited to written text: it can incorporate images, illustrations, software screenshots, training links, short videos, review questions, and performance examples (De Silva & Peramunugamage, 2023). More broadly, e-guidebooks and e-books offer varied opportunities for interaction through their diverse stimuli, and are characterized by ease of use, speed, continuous updatability, and easy sharing — while also reducing physical space requirements, making them well suited to distance learning (Al-Sulaimani & Faraj, 2021).

Beyond convenience, e-guidebooks can help address individual differences among learners and the challenge of navigating an overabundance of educational materials, in part through their capacity for quick information retrieval. Sulaimani (2024), for example, reports a positive association between e-book use and improvements in learners' academic achievement and skills — though as with other findings cited in this review, this association is drawn from a specific study context and should be interpreted with appropriate caution regarding generalizability.

The importance of e-guidebooks in fashion design education is closely tied to the nature of the discipline itself. Pattern drawing is an applied field that combines aesthetic and technical considerations, requiring students to move deliberately from conceptualization to drawing, from drawing to pattern drafting, and from pattern drafting to the finished product. Because this sequence is highly structured, an error introduced at an early stage can compromise the quality of the design or the fit of the finished garment. An e-guidebook therefore helps provide a clear learning roadmap — clarifying what is required of students, which tools they will use, which steps to follow, and the criteria against which their performance will be assessed (Conlon, 2024).

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This reliance on structured, sequential guidance is amplified as pattern-drawing education shifts from manual to computer-based methods. Students must now learn not only the foundational rules of pattern making but also how to implement those rules through digital software — a dual demand that makes the role of the e-guidebook in bridging traditional pattern-making knowledge and modern technical skills more important still (De Silva & Peramunugamage, 2023). This bridging function is particularly evident in how an e-guidebook can visually and systematically illustrate the steps involved in constructing a basic pattern: determining the starting point, drawing the basic rectangles, distributing measurements, defining the chest, waist, and hip lines, drawing the neckline and armholes, determining dart placement, and verifying line accuracy. Presented only in written form, such steps can be difficult for some students to follow; presented electronically with illustrative images or software screenshots, they become considerably clearer and more applicable (Evangelista & Villanueva, 2025).

Summary and Positioning of the Present Study

The literature establishes two consistent points: first, that computer-aided pattern drawing has become a core competency in fashion design education and practice, rather than a peripheral technical add-on; and second, that the effective teaching of this competency depends heavily on well-structured, sequential instructional materials — particularly electronic guidebooks capable of combining visual, textual, and interactive elements. However, much of this literature addresses the general pedagogical value of e-guidebooks and CAD instruction, with comparatively little attention paid to the design and empirical testing of a specific guidebook for teaching computer-aided pattern drawing at the undergraduate level. It is this gap that the present study seeks to address.

Research Methodology

The study adopted a single-group, pre-experimental design (pre-test/post-test), following Campbell and Stanley's (1963) classification of experimental research designs. This design was selected for its practicality in achieving the research objectives within the constraints of a single-semester, single-section course, where random assignment to a control group was not feasible given the institutional setting. The study focused on designing and applying Lesson 5 from the computer-aided pattern drawing guidebook with a sample of female fashion design students, in order to test the following hypotheses:

1. There are statistically significant differences between the mean scores of students on the pre-test and post-test of cognitive achievement, favoring the post-test.
2. There are statistically significant differences between the mean scores of students on the pre-test and post-test of skills, favoring the post-test.
3. There are statistically significant differences between students' responses on the attitude scale toward the guidebook and the neutral midpoint of the scale, favoring a positive attitude.

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As this design does not include a control or comparison group, the observed pre-test/post-test differences cannot be attributed to the guidebook intervention alone; factors such as testing effects, maturation, and concurrent classroom instruction may also contribute to the results.

Study Sample

The study was conducted with a sample of 60 female fashion design students at the undergraduate level, enrolled in the Computer-Aided Pattern Drawing course (DAFD 323) at the College of Art and Design, University of Jeddah. Participants were purposively selected on the basis of their enrollment in this course, which made them directly relevant to the research topic and ensured that all participants shared a comparable foundation in pattern-drawing instruction prior to the intervention. The same group of students completed both the pre-test and post-test, allowing within-subject comparison of cognitive and skill outcomes before and after using the guidebook. Participation was voluntary, and informed consent was obtained from all students prior to data collection.

Research Procedures

The study was conducted according to the following procedures:

1. Designing a computer-aided pattern drawing guidebook;
2. Designing the research instruments;
3. Verifying the validity and reliability of the research instruments;
4. Administering the pre-test and guidebook-based instruction, followed by the post-test;
5. Applying appropriate statistical analysis tools to analyze the results.

Research Instruments

The following instruments were developed in accordance with the study's methodology and objectives:

- A guidebook prepared by the researchers;
- A form for assessing the proposed guidebook (completed by specialist reviewers);
- A cognitive achievement test (administered as both pre-test and post-test), designed to measure the knowledge acquired by the sample students;
- A skill achievement test (administered as both pre-test and post-test), designed to measure the skills acquired by the sample students;
- A skills performance rubric, used to score responses on the skill achievement test;
- A student attitude scale, used to measure students' attitudes toward the guidebook following the intervention.

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Image (1-1) Cover of the proposed guidebook (prepared by the researchers)

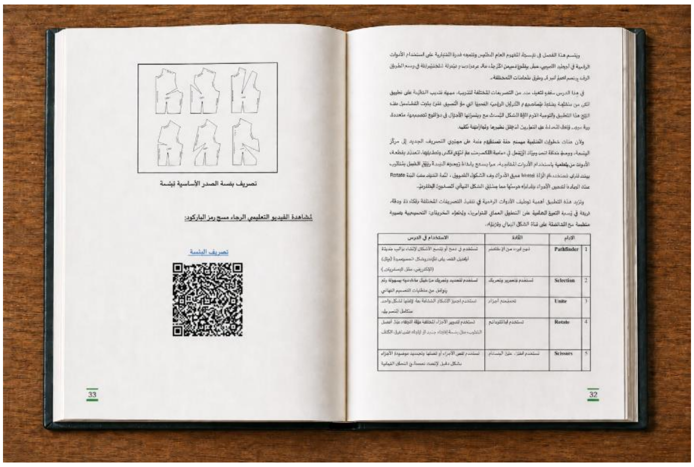

Image (1-2) A guidebook to learning digital skills in drawing flat models (prepared by the researchers)

Validity and Reliability

First — The Proposed Guidebook Evaluation Scale

The researchers prepared the final version of the guidebook evaluation scale in light of the study's research concepts and terms, and within the framework of its operational definitions and relevant literature. The scale included 15 declarative items assessing the effectiveness of the guidebook for teaching digital skills in flat pattern drawing. Members of the study sample responded to each item on a five-point scale (strongly agree, agree, neutral, disagree, strongly disagree), scored on a continuum of 5, 4, 3, 2, and 1, respectively. Total scores ranged from a minimum of 15 to a maximum of 75.

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1. Scale Validity

To verify the scale's validity, the researchers adopted two methods: content validity and internal consistency validity.

A. Content Validity

The initial draft of the guidebook evaluation scale was submitted to a panel of expert professors from the College of Art and Design, University of Jeddah, for review. Reviewers were asked to evaluate the accuracy of the linguistic formulation of each item, the integrity of the scale's content, and the appropriateness of the items in relation to their intended purpose. Based on the panel's feedback, the researchers revised the wording of several items, thereby establishing the scale's content validity.

B. Internal Consistency Validity

To assess internal consistency validity, the scale was administered to a pilot sample of 60 female fashion design students who were not included in the main study sample. Responses were then processed, and Pearson's correlation coefficient was calculated between each item's score and the total scale score. The results are presented in Table (1-1).

Table (1-1) Pearson's Correlation Coefficients for the Proposed Guidebook Evaluation Scale

Item	Correlation Coefficient	Sig.	Item	Correlation Coefficient	Sig.	Item	Correlation Coefficient	Sig.
1	0.705*	<0.001	6	0.806*	<0.001	11	0.782*	<0.001
2	0.749*	<0.001	7	0.764*	<0.001	12	0.819*	<0.001
3	0.775*	<0.001	8	0.738*	<0.001	13	0.773*	<0.001
4	0.788*	<0.001	9	0.723*	<0.001	14	0.768*	<0.001
5	0.849*	<0.001	10	0.736*	<0.001	15	0.824*	<0.001

*Significant at the 0.01 level.

As shown in Table (1-1), all items on the proposed guidebook evaluation scale showed strong, statistically significant positive correlations with the total scale score, with Pearson's coefficients ranging from 0.705 to 0.849 ($p < 0.01$). These results support the internal consistency of the scale's items and confirm its validity for measuring the intended construct.

2. Scale Reliability

The reliability of the guidebook evaluation scale was assessed by calculating internal consistency reliability using Cronbach's alpha coefficient, as shown in Table (1-2).

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Table (1-2) Reliability Coefficient for the Proposed Guidebook Evaluation Scale

Number of Items	Cronbach's Alpha
15	0.802

As shown in Table (1-2), the scale achieved a high Cronbach's alpha coefficient of 0.802, confirming its reliability and its suitability for application with the study sample.

Second — The Cognitive Achievement Test

In light of the study's general and procedural objectives, a cognitive achievement test was designed to measure the cognitive level of the sample of female fashion design students, specifically regarding the cognitive aspects of learning digital skills in flat pattern drawing. The test was developed through the following stages.

1) Determining and Formulating the Test Items

A review of the literature on assessment methods and tools indicated that objective test formats — true/false, multiple-choice, and matching items — are well suited to measuring cognitive achievement, given their flexibility, ease of objective scoring, and capacity to measure learning outcomes accurately.

Based on this review, the test was developed with 15 items: 5 true/false items, 5 multiple-choice items (each with a premise and three alternatives, to reduce the probability of guessing), and 5 matching items. In developing these items, the researchers attended to linguistic accuracy and clarity of question formulation; comparable length across alternatives; consistency between each alternative and the linguistic structure of its premise; equivalence among alternatives, without cues favoring any one option; a single, unambiguous correct answer per item; random distribution of correct answers to minimize response-pattern guessing; and consistency of alternative format across items.

2) Setting Test Instructions

Test instructions were designed to be simple, clear, and appropriate to the sample's academic level, and were placed at the beginning of the test with ten minutes allocated for students to read them before beginning. The instructions specified the requirement to answer all questions, described the number and types of questions included, and stated the time allotted for completion.

3) Test Validity

Two methods were used to verify the validity of the cognitive achievement test: content validity and internal consistency validity.

A. Content Validity

The initial version of the test was submitted to a panel of expert professors from the College of Art and Design, University of Jeddah, who evaluated the linguistic accuracy, content coverage, and appropriateness of the vocabulary used across question types. Based on their feedback, the researchers revised the wording of several items to strengthen the test's content validity.

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B. Internal Consistency Validity

Internal consistency was assessed by calculating Pearson's correlation coefficient between the score for each question type and the total test score, as shown in Table (1-3).

Table (1-3) Internal Consistency of the Cognitive Achievement Test

Question Type	Number of Items	Correlation Coefficient
True/False	5	0.857*
Multiple Choice	5	0.886*
Matching	5	0.801*

*Significant at the 0.01 level.

As shown in Table (1-3), the correlation coefficients for all three question types were statistically significant at the 0.01 level, ranging from 0.801 to 0.886. These results support the internal consistency of the cognitive achievement test.

4) Calculating Test Reliability

Reliability refers to a test's ability to produce consistent results when administered repeatedly under similar conditions. The reliability of the cognitive achievement test was calculated using Cronbach's alpha coefficient, both for each question type and for the test as a whole, as shown in Table (1-4).

Table (1-4) Reliability Coefficients for the Cognitive Achievement Test

Question Type	Number of Items	Cronbach's Alpha
True/False	5	0.886
Multiple Choice	5	0.902
Matching	5	0.895
Overall Test	**15**	**0.890**

As shown in Table (1-4), the cognitive achievement test demonstrated a high degree of reliability, with Cronbach's alpha values for individual question types ranging from 0.886 to 0.902, and an overall alpha coefficient of 0.890 for the test as a whole. These results support the reliability of the test and strengthen confidence in the findings obtained from its application to the research sample.

5) Calculating Difficulty Indices

The difficulty index for each item in the cognitive achievement test was calculated using the standard difficulty index formula, based on the proportion of students who answered each item correctly.

$$\frac{Number\ of\ those\ who\ answered\ correctly}{Number\ of\ Students} = Difficulty\ Index$$

Difficulty index values ranged from 0.42 to 0.76 across all items, indicating an acceptable level of test difficulty — that is, items were neither too easy nor too difficult for the sample. Table (1-5) presents the difficulty index for each item.

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Table (1-5) Difficulty Indices for the Cognitive Achievement Test

Item	True/False	Item	Multiple Choice	Item	Matching
1	0.46	1	0.44	1	0.43
2	0.70	2	0.75	2	0.76
3	0.74	3	0.69	3	0.60
4	0.58	4	0.68	4	0.42
5	0.72	5	0.55	5	0.51

6) Calculating Discrimination Coefficients

The discrimination coefficient reflects a test item's ability to distinguish between higher- and lower-achieving students. This was calculated using the pilot sample by ranking students' total scores in descending order, dividing them into upper and lower groups, and calculating the discrimination index for each item as the difference in the proportion of correct responses between the two groups. Discrimination index values ranged from 0.69 to 0.82 across all items, indicating good discriminatory power and supporting the suitability of the test items for application with the main sample. Table (1-6) presents the discrimination index for each item.

Table (1-6) Discrimination Coefficients for the Cognitive Achievement Test

Item	True/False	Item	Multiple Choice	Item	Matching
1	0.80	1	0.75	1	0.78
2	0.82	2	0.69	2	0.82
3	0.69	3	0.71	3	0.76
4	0.72	4	0.75	4	0.77
5	0.72	5	0.72	5	0.74

7) Setting the Test Time

The time required to complete the cognitive achievement test was estimated using a standard test-time formula based on item response times from the pilot administration. The resulting optimal testing time was approximately 20 minutes, plus an additional 10 minutes allocated for reading the test instructions. This time allocation was applied consistently during both the pre-test and post-test administrations with the main sample.

8) The Final Version of the Cognitive Achievement Test

The final version of the cognitive achievement test comprised 15 items: 5 true/false questions, 5 multiple-choice questions, and 5 matching questions. The test was scored out of 15 points and administered within 30 minutes. An answer key and corresponding scoring key were prepared and are included as an appendix.

Third — The Skills Test

Based on the study's procedural objectives and educational content, a skills test was designed and developed through the following stages.

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1. Defining the Test Objective

The skills test was developed to measure the skill level of the sample of female fashion design students, particularly regarding the digital skills involved in flat pattern drawing, and was administered as both a pre-test and a post-test.

2. Determining and Formulating the Test Items

The skills test consisted of a single essay-type task, designed to require students to apply the digital pattern-drawing skills targeted by the guidebook.

3. Developing the Test Instructions

Test instructions were designed to guide students in completing the task correctly, including a brief introduction to the test, an emphasis on clarity and conciseness, the total test duration, and the total score available.

4. Test Validity

To establish content validity, the initial version of the skills test was reviewed by a panel of expert professors from the College of Art and Design, University of Jeddah, who evaluated the relevance of the test task to the research objectives, its comprehensiveness, and the accuracy and clarity of its wording. The reviewing panel reached full agreement on the test's content validity.

5. Test Time Estimation

The time required to complete the skills test was estimated based on pilot administration data using

$$\frac{Total\ Answer\ Time}{Number\ of\ Students} = Testing\ time$$

The resulting optimal testing time was approximately 50 minutes, plus an additional 10 minutes allocated for reading the test instructions. This time allocation was applied consistently during both the pre-test and post-test administrations with the main sample.

6. Test Scoring Method

Because the skills test consisted of a single essay-type task rather than discrete scoreable items, a traditional item-based reliability coefficient could not be calculated for the test itself. Instead, a skills performance rating scale was developed to provide a structured and reliable basis for scoring student responses, as described below.

Fourth — Skills Performance Rating Scale

The researchers followed these procedures to develop the skills performance rating scale.

1. Defining the Objective of the Skills Performance Rating Scale

The scale was designed to measure the performance dimensions demonstrated by female fashion design students in completing the skills test.

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2. Defining the Items Included in the Skills Performance Rating Scale

The final version of the scale included five declarative items measuring specific components of students' skill performance. Each item was scored on a six-point scale ranging from 0 to 5, and total scores were derived by summing across all five items.

3. Verifying Scale Validity

To establish content validity, the scale was submitted to a panel of expert reviewers, who evaluated its comprehensiveness in covering the targeted skills, its effectiveness in measuring the intended skill objectives, the clarity and usability of its items, and the linguistic accuracy of its wording. Reviewers reached full agreement (100%) on the scale's content coverage and clarity.

4. Calculating Scale Reliability

Cronbach's alpha was used to calculate the scale's internal consistency reliability coefficient, as shown in Table (1-7).

Table (1-7) Reliability Coefficient of the Skills Performance Rating Scale

Number of Items	Cronbach's Alpha
5	0.877

As shown in Table (1-7), the skills performance rating scale achieved a Cronbach's alpha coefficient of 0.877, indicating a high level of internal consistency reliability and supporting the scale's use for scoring the skills test.

Fifth — The Scale of Students' Attitudes Toward the Guidebook

The attitude scale aimed to measure students' attitudes toward the guidebook for learning digital skills in flat pattern drawing. The scale consisted of 12 items based on a three-point Likert format, with students selecting one of three response options for each item - agree, neutral, or disagree— scored on a continuum of 3, 2, and 1, respectively, according to the intensity of their attitude. The researchers followed the steps below to construct and validate the scale.

1. Scale Validity

To determine the validity of the attitude scale, it was submitted to a panel of expert reviewers, who evaluated the scale's comprehensiveness in capturing the study sample's attitudes, its effectiveness in measuring affective objectives, the clarity and simplicity of its items, and the linguistic accuracy of its wording. The agreement rate among reviewers was 98.81%, indicating a high level of expert consensus on the scale's content validity.

2. Scale Reliability

The reliability of the attitude scale was assessed by calculating internal consistency reliability using Cronbach's alpha coefficient, as shown in Table (1-8).

Table (1-8) Reliability Coefficient of the Student Attitude Scale

Number of Items	Cronbach's Alpha
12	0.897

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As shown in Table (1-8), the attitude scale achieved a high Cronbach's alpha coefficient of 0.897, indicating a strong degree of internal consistency reliability and supporting confidence in the results obtained from this instrument.

Results

1.1 Specialist Evaluation of the Proposed Guidebook (Sub-Research Question 1)

To answer the first sub-research question — "What are the opinions of specialists regarding the suitability of the guidebook for the Basic Computer-Aided Pattern Drawing Course?" — a chi-square goodness-of-fit test was used to examine whether specialists' responses to the guidebook evaluation scale were distributed unevenly across response categories. Table (1-9) presents the chi-square values for the frequency of specialists' responses (n = 9) to each item of the scale.

Table (1-9) Chi-Square Values for the Frequency of Specialist Responses to the Guidebook Evaluation Scale (n = 9)

Item	Strongly Agree	Agree	Neutral	χ^2	Sig.
1	9, 100	–	–	36.000	<0.001
2	9, 100	–	–	36.000	<0.001
3	8, 88.9	1, 11.1	–	27.111	<0.001
4	7, 77.8	2, 22.2	–	20.444	<0.001
5	7, 77.8	2, 22.2	–	20.444	<0.001
6	8, 88.9	1, 11.1	–	27.111	<0.001
7	7, 77.8	2, 22.2	–	20.444	<0.001
8	8, 88.9	1, 11.1	–	27.111	<0.001
9	7, 77.8	2, 22.2	–	20.444	<0.001
10	7, 77.8	2, 22.2	–	20.444	<0.001
11	7, 77.8	1, 11.1	1, 11.1	19.333	<0.001
12	7, 77.8	2, 22.2	–	20.444	<0.001
13	7, 77.8	2, 22.2	–	20.444	<0.001
14	8, 88.9	1, 11.1	–	27.111	<0.001
15	7, 77.8	1, 11.1	1, 11.1	19.333	<0.001

Significance level = 0.05; degrees of freedom = 4.

As shown in Table (1-9), responses were concentrated heavily in the "strongly agree" category across all 15 items, with endorsement rates ranging from 77.8% to 100%. Chi-square values were statistically significant for all items ($p < 0.001$), indicating that specialists' responses were not evenly distributed across response categories but were instead concentrated toward the positive end of the scale.

1.2 Cognitive Achievement: Pre-Test vs. Post-Test (Hypothesis 1)

Hypothesis 1 stated: "There are statistically significant differences between the mean scores of the female students in the pre- and post-tests of the cognitive achievement test, favoring the post-test." A paired-samples t-test was conducted comparing students' pre-test and post-test scores on the cognitive achievement test. Table (1-10) presents the results.

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Table (1-10) Paired-Samples t-Test Results for the Cognitive Achievement Test (n = 60)

Application	N	Mean	SD	df	t	Sig.
Pre-test	60	8.38	2.787	59	−18.947	<0.001
Post-test	60	14.92	0.334			

As shown in Table (1-10), there was a statistically significant difference between students' mean scores on the pre-test ($M = 8.38$, $SD = 2.787$) and post-test ($M = 14.92$, $SD = 0.334$) of the cognitive achievement test, $t(59) = -18.947$, $p < 0.001$, favoring the post-test. Hypothesis 1 is therefore supported.

1.3 Skills Achievement: Pre-Test vs. Post-Test (Hypothesis 2)

Hypothesis 2 stated: "There are statistically significant differences between the mean scores of the female students in the pre- and post-tests of the skills test, favoring the post-test." A paired-samples t-test was again used to compare students' pre-test and post-test scores on the skills test. Table (1-11) presents the results.

Table (1-11) Paired-Samples t-Test Results for the Skills Test (n = 60)

Application	N	Mean	SD	df	t	Sig.
Pre-test	60	3.57	4.002	59	−38.751	<0.001
Post-test	60	24.17	1.932			

As shown in Table (1-11), there was a statistically significant difference between students' mean scores on the pre-test ($M = 3.57$, $SD = 4.002$) and post-test ($M = 24.17$, $SD = 1.932$) of the skills test, $t(59) = -38.751$, $p < 0.001$, favoring the post-test. Hypothesis 2 is therefore supported.

1.4 Effectiveness of the Guidebook (Sub-Research Question 2)

To answer the second sub-research question — "To what extent is the guidebook effective in developing computer-aided pattern drawing skills?" — the effectiveness of the guidebook was calculated using Black's modified gain ratio:

$$\text{Modified Gain} = \frac{\bar{X}_{post} - \bar{X}_{pre}}{d - \bar{X}_{pre}}$$

where X¯post\bar{X}_{post} X¯post is the mean post-test score, X¯pre\bar{X}_{pre} X¯pre is the mean pre-test score, and d is the maximum possible test score. Following Black (1976), a modified gain ratio between 1 and 2 is considered acceptable evidence of instructional effectiveness.

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Table (1-12) Modified Gain Ratio for the Cognitive Achievement Test

Pre-Test Mean	Post-Test Mean	Max Score (d)	Modified Gain
8.38	14.92	15	1.42

Table (1-13) Modified Gain Ratio for the Skills Test

Pre-Test Mean	Post-Test Mean	Max Score (d)	Modified Gain
3.57	24.17	25	1.79

As shown in Tables (1-12) and (1-13), the modified gain ratios for the cognitive achievement test (1.42) and the skills test (1.79) both fall within Black's acceptable range of 1 to 2, indicating that the guidebook was effective in helping students reach the required level of learning in both the cognitive and skill dimensions of computer-aided pattern drawing.

1.5 Student Attitudes Toward the Guidebook (Sub-Research Question 3)

To answer the third sub-research question — "What is the students' attitude toward the guidebook for developing their computer-aided pattern drawing skills?" — a chi-square goodness-of-fit test was used to examine the distribution of student responses to the attitude scale. Table (1-14) presents the results.

Table (1-14) Chi-Square Values for the Frequency of Student Responses to the Attitude Scale (n = 60)

Item	Agree (#, %)	Neutral (#, %)	Disagree (#, %)	χ^2	Sig.
1	57, 95.00	3, 5.00	–	102.90	<0.001
2	51, 85.00	9, 15.00	–	66.30	<0.001
3	54, 90.00	6, 10.00	–	82.80	<0.001
4	52, 86.67	8, 13.33	–	71.20	<0.001
5	58, 96.67	2, 3.33	–	110.80	<0.001
6	56, 93.33	4, 6.67	–	95.60	<0.001
7	55, 91.67	5, 8.33	–	89.10	<0.001
8	52, 86.67	8, 13.33	–	71.20	<0.001
9	56, 93.33	4, 6.67	–	95.60	<0.001
10	55, 91.67	5, 8.33	–	89.10	<0.001
11	56, 93.33	4, 6.67	–	95.60	<0.001
12	55, 91.67	5, 8.33	–	89.10	<0.001

Significance level = 0.05; degrees of freedom = 2. χ^2 values computed as goodness-of-fit tests against equal expected frequencies (E = 20 per category); verify against original statistical output before submission.

As shown in Table (1-14), responses were concentrated heavily in the "Agree" category across all 12 items, ranging from 85.0% to 96.67%. Chi-square values were statistically significant for all items ($p < 0.001$), indicating that student attitudes toward the guidebook were consistently and significantly positive.

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Discussion

The present study set out to design and evaluate a guidebook for teaching digital skills in flat pattern drawing, examining its effectiveness across three complementary dimensions: expert judgment of its instructional quality, measurable gains in student cognitive achievement and skill performance, and students' own attitudes toward using it. Taken together, the results converge on a consistent and encouraging picture — one that also invites careful interpretation rather than unqualified acceptance.

Convergence across independent measures

The most notable feature of these findings is not any single result in isolation, but the degree to which four largely independent lines of evidence point in the same direction. Specialists evaluating the guidebook's design endorsed it overwhelmingly (Table 1-9); students demonstrated large, statistically significant gains in both cognitive knowledge ($t(59) = -18.947$, $p < .001$) and applied skill performance ($t(59) = -38.751$, $p < .001$); Black's modified gain ratios for both measures fell within the range associated with effective instruction; and students themselves reported strongly positive attitudes toward the guidebook after using it (Table 1-14). It is one thing for a guidebook to be well regarded in principle, and another for it to produce measurable learning gains and be well received by the students who actually work through it — here, expert judgment, objective performance data, and subjective learner experience all tell the same story.

This pattern is broadly consistent with the theoretical framework outlined earlier in this paper. The gains observed here support Zhu's (2023) contention that CAD proficiency functions as a core, rather than peripheral, competency in contemporary garment product development, and align with Widowati et al.'s (2024) argument that effective CAD instruction depends on structured, cumulative guidance rather than unmediated exposure to the software itself. The strongly positive attitude results likewise echo De Silva and Peramunugamage's (2023) observation that electronic guidebooks help standardize the learning experience across students with varying starting points.

The skill gains were the most pronounced result

Of the two achievement measures, the improvement in skill performance was substantially larger in relative terms than the improvement in cognitive achievement — pre-test skill scores were extremely low ($M = 3.57$ out of 25, roughly 14% of the maximum), rising to $M = 24.17$ post-test (nearly 97% of the maximum). This suggests that, prior to the intervention, students had almost no functional ability to execute the applied digital pattern-drawing task the skills test assessed, and that this gap was where the guidebook had its largest measurable impact — consistent with the broader argument in the literature that software access alone does not translate into skill acquisition without structured, sequential instructional guidance (Widowati et al., 2024).

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Interpreting the cognitive ceiling effect

The cognitive achievement results, while highly significant, warrant a more cautious reading than the topline statistics alone suggest. The post-test standard deviation (SD = 0.334) was dramatically smaller than the pre-test standard deviation (SD = 2.787), indicating that the large majority of students scored at or near the maximum possible score (15) after using the guidebook. This reflects genuinely strong knowledge acquisition, but it also means the test had little remaining room to differentiate among students at the top of the distribution. This does not undermine the finding that students learned the material; it does suggest that a more difficult or more granular cognitive assessment in future work could offer a more sensitive picture of exactly how much — and which aspects of — cognitive understanding the guidebook produced.

What the design can and cannot tell us

The most important qualification to these findings concerns the study's design. As a single-group, pre-experimental design without a control or comparison group, this study is well suited to demonstrating that change occurred, but it cannot, on its own, isolate the guidebook as the sole cause of that change. Testing effects, general maturation over the semester, and concurrent classroom instruction alongside the guidebook remain plausible contributing explanations that this design cannot rule out. This is a limitation common to much of the applied, classroom-embedded research this study builds on, and it does not invalidate the findings; it means the appropriate claim is that the guidebook is associated with strong, positive learning outcomes in this context, rather than that it is demonstrably their sole cause.

Reading the specialist and attitude evaluations together

The specialist evaluation (Section 1.1) and student attitude results (Section 1.5) are usefully read side by side, since both relied on chi-square analyses of concentrated, positively skewed response patterns, and both share a related caveat: in each case, virtually no respondents selected a negative response option, meaning the analysis is better understood as confirming strong, near-unanimous endorsement than as discriminating fine-grained differences in perceived quality across items. For the specialist panel specifically, this should also be weighed against its small size ($n = 9$), which limits how confidently the result generalizes beyond this particular panel. Neither caveat diminishes the finding that both groups viewed the guidebook favorably; it means these results are best read as strong directional evidence of acceptance, rather than fine-grained diagnostic data about specific strengths or weaknesses within the guidebook.

Practical significance

Beyond statistical significance, the practical significance of these findings is considerable in an applied, skills-based discipline like fashion design. The scale of improvement in skill performance — from near-floor to near-ceiling — suggests that a well-structured, sequential digital guidebook can meaningfully close a substantial

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skills gap within a single instructional unit, directly supporting the course's aim of preparing students for a job market that increasingly expects CAD proficiency (Zhu, 2023). This lends practical weight to the broader argument, raised in the introduction, that unstructured or printed-only instructional materials are no longer sufficient for teaching applied digital skills in fashion education (Conlon, 2024).

Conclusions

This study examined the effectiveness of a purpose-designed guidebook for teaching digital skills in flat pattern drawing, evaluated through specialist review, student cognitive and skill achievement, guidebook effectiveness indices, and student attitudes.

Specialists reviewing the guidebook expressed highly positive and consistent opinions regarding its suitability for teaching the Basic Computer-Aided Pattern Drawing course, with chi-square results confirming strong consensus across all evaluated items. Students who used the guidebook showed statistically significant improvement from pre-test to post-test on both the cognitive achievement test and the skills test, with Black's modified gain ratios (1.42 and 1.79, respectively) confirming that this improvement met the threshold associated with effective instruction. Students' attitudes toward the guidebook were likewise strongly positive, with the large majority agreeing across all items of the attitude scale.

Together, these results indicate that the proposed guidebook was effective in developing students' cognitive understanding and applied skills in computer-aided pattern drawing, and was well received by both the specialists who evaluated it and the students who used it. At the same time, as discussed above, these conclusions are best understood within the boundaries of a single-group, pre-experimental design conducted at one institution — a scope that the recommendations below take directly into account.

Recommendations

In light of these results, and taking into account the limitations discussed above, the researchers recommend the following:

1. Adopt the guidebook for continued use. The proposed guidebook should be adopted as an e-learning resource for teaching computer-aided pattern drawing in the Basic Computer-Aided Pattern Drawing course, given the consistent evidence of its effectiveness and positive reception.
2. Extend the model to other courses. Faculty should consider developing similar structured, sequential e-guidebooks for other applied fashion design courses, using the design and validation process followed here as a template.
3. Support faculty in producing interactive digital learning materials. Institutions should encourage and support faculty members in designing interactive e-books and guidebooks for fashion and textiles education more broadly, as part of a wider shift toward self-directed digital learning resources.
4. Test the guidebook against a comparison condition. Because the present study used a single-group design, future research should evaluate the guidebook using a

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quasi-experimental design with a comparison group — for example, students taught through conventional instruction alone — to determine more precisely the guidebook's specific contribution relative to testing effects, maturation, or concurrent classroom instruction.

5. Refine the cognitive assessment for greater sensitivity. Given the ceiling effect observed on the cognitive achievement post-test, future evaluations of the guidebook should consider a more challenging or more finely graded cognitive assessment capable of distinguishing among higher-performing students.
6. Broaden the specialist evaluation panel. Future validation of the guidebook, or of similar instructional materials, should draw on a larger and more diverse panel of specialist reviewers to strengthen the generalizability of expert evaluation findings.
7. Replicate across institutions and cohorts. Given that this study was conducted with a single sample at one institution, replication with different student cohorts and institutional contexts would help establish the extent to which these findings generalize beyond the present setting.

Author Statements

Conflicts of Interest

The authors declare that they have no known financial or personal relationships that could have appeared to influence the work reported in this manuscript. No competing interests exist.

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Author Contributions

FA: Conceptualization, methodology, instructional guidebook design, data collection, formal analysis, interpretation of results, writing the original draft, and manuscript revision.
DK: Study supervision, methodology refinement, validation, review and editing of the manuscript, interpretation of findings, and final approval of the manuscript.
All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the manuscript are appropriately investigated and resolved.

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