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The Relationship between Knowledge and Pattern Drafting Skills and Mastery of Calculation Techniques in Garment Pattern Making among Fashion Student

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ABSTRACT

Home Economics Education (HEE) plays an important role in developing technically skilled students in the field of fashion, particularly in garment pattern making, which requires precise calculation skills. However, studies examining the relationship between knowledge, pattern drafting skills, and mastery of calculation techniques among students in Malaysia remain limited. Therefore, this study aims to identify the levels of calculation skills, knowledge, and pattern drafting skills among students, as well as to analyse the relationships between these variables in the context of garment pattern production. This study employed a quantitative approach using a survey research design. A total of 124 students were selected as respondents through stratified random sampling. Data were collected using a questionnaire and analysed using descriptive statistics (mean and standard deviation) and inferential statistics (Pearson correlation) via SPSS software. The findings indicate that pattern drafting skills recorded the highest mean score (M = 3.74, SD = 0.79), followed by knowledge (M = 3.57, SD = 0.75) and mastery of calculation techniques (M = 3.57, SD = 0.76). Pearson correlation analysis revealed a very strong and significant positive relationship between knowledge ($r = 0.767$, $p < 0.005$) and pattern drafting skills ($r = 0.765$, $p < 0.005$) with mastery of calculation techniques in garment pattern making. The implications of this study highlight the need to strengthen teaching strategies by integrating contextual and practical mathematical elements within the HEE curriculum to enhance students' technical competencies in line with industry requirements.

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1. Introduction

In the era of globalisation, Home Economics Education (HEE) plays a vital role in producing highly skilled students, particularly in garment pattern making, which requires mastery of mathematical concepts such as measurement, proportion, and calculation. However, classroom realities indicate that students still face various challenges in applying mathematical concepts in practical contexts [2]. Weaknesses in basic mathematical proficiency have been identified as one of the main factors affecting students' ability to produce accurate garment patterns. Many students struggle to understand fundamental concepts such as measurement and proportion, which are essential elements in pattern construction. A study by Mahamad Nadzar [28] shows that errors in calculation and measurement frequently occur, thereby affecting the quality of pattern outcomes. This reflects the need for teaching approaches that more effectively integrate mathematical concepts with practical application. In addition, spatial visualisation skills also present a challenge in the pattern-making process. Weaknesses in this aspect cause students to struggle to visualise the relationship between mathematical values and pattern shapes, thereby affecting design accuracy. Mamat [30] found that a lack of spatial visualisation skills negatively impacts students' work outcomes. In the context of research, studies on the relationship between mathematical knowledge and practical skills in HEE education remain limited, particularly in Malaysia. Most previous studies focus more on students' perceptions rather than empirical evaluation of their actual competency. This gap highlights the need to systematically examine the level of mathematical mastery and its relationship with pattern drafting skills.

Garment pattern making in Home Economics Education (HEE) is a technical process that requires the integration of mathematical knowledge with practical skills, particularly in measurement, proportion, scaling, and calculation. The relationship between mathematics and art in garment construction has long existed since early civilisations such as Egypt and Greece, which applied geometric principles to produce balanced and aesthetically pleasing designs [14]. In the context of modern education, mathematical proficiency is essential to ensure pattern accuracy, as calculation errors may compromise the quality of the final product [2]. In line with the emphasis on Technical and Vocational Education and Training (TVET), HEE education must ensure that students are able to apply mathematical concepts in practical situations. However, students still face challenges in mastering mathematical skills, particularly in spatial visualisation and the application of calculations in practical work. Weaknesses in interpreting the relationship between numerical values and physical forms lead to difficulties in producing accurate patterns [30]. Although the use of aids such as measuring tape charts can enhance basic understanding [28], this approach still lacks comprehensive integration between mathematical theory and practical application. Ethnomathematics approaches that integrate cultural elements such as songket and batik have shown potential in helping students understand mathematical concepts in a more contextualised manner [21,27]. However, its application in Home Economics Education (ERT) in Malaysia remains limited [41]. At the international level, the use of precise mathematical concepts has been shown to improve the quality of pattern production [22,36]. Nevertheless, empirical studies examining the relationship between knowledge, pattern drafting skills, and mastery of calculation techniques in the context of HEE in Malaysia are still limited.

Objectives

1. To identify the level of mastery of calculation techniques in garment pattern making.
2. To identify the level of knowledge and pattern drafting skills in garment pattern making.

3. To identify the level of pattern drafting skills in garment pattern making.
4. To analyse the relationship between the level of knowledge and mastery of calculation techniques in garment pattern making.
5. To analyse the relationship between the level of pattern drafting skills and mastery of calculation techniques in garment pattern making.

2. Literature Review

Mastery of Calculation Techniques

Mastery of calculation techniques is a critical foundation in garment pattern making, as it involves translating three-dimensional body measurements into accurate two-dimensional patterns [10]. Proficiency in basic mathematical concepts such as division, proportion, and unit conversion is essential to ensure structural accuracy and proper garment fit [26]. A lack of these skills may lead to technical errors that affect both the functionality and aesthetic quality of the final product. In addition, understanding geometric concepts, spatial reasoning, and principles of symmetry enables students to effectively visualise the relationship between pattern pieces and the human body [43]. Symmetry ensures visual balance across garment components such as sleeves, collars, and body panels, thereby enhancing design professionalism and visualisation skills [24,37]. Mastery of geometric principles also supports zero-waste pattern drafting techniques, which maximise fabric utilisation and reduce material waste. This approach is crucial in fabric estimation and resource management, where accurate calculations help optimise material use, reduce costs, and promote sustainable practices in the fashion industry [42,44]. Although Computer-Aided Design (CAD) technology enhances pattern accuracy, a strong foundation in mathematics remains necessary to evaluate and refine digital outputs [23,47]. Overall, mastery of calculation techniques integrates mathematical proficiency, spatial reasoning, and material efficiency, forming the basis of professionalism among Home Economics Education (ERT) students in meeting the demands of a competitive and sustainable fashion industry [43].

Knowledge

Knowledge of basic pattern making is a fundamental pillar in fashion design education, as it provides the technical framework for every design [4]. Understanding the sloper enables students to translate creativity into wearable forms, whereas a lack of mastery may result in patterns that are not ergonomic [39]. In addition, proficiency in spatial reasoning and geometric principles allows students to accurately visualise the transformation from two-dimensional (2D) to three-dimensional (3D) forms, thereby improving garment fit and quality [1,9,45]. Furthermore, knowledge of anthropometry helps students understand the relationship between actual body measurements and pattern construction, ensuring comfort and appropriate ease in garments.

From a pedagogical perspective, the use of interactive media such as video tutorials and e-modules enhances student engagement and strengthens their knowledge schema [46]. Creative teaching aids can also reduce students' anxiety towards technical complexity, thereby improving their mastery of basic pattern theory [33]. In addition, the integration of digital technologies such as Computer-Aided Design (CAD) accelerates the visualisation process and facilitates pattern simulation; however, a solid foundation in manual techniques remains essential for effective software utilisation [1,7,29]. Overall, a strong knowledge base encompassing basic pattern theory, anthropometry, tool proficiency, and technological adaptation enables students to integrate

creativity with technical precision, ultimately shaping competent fashion professionals who are prepared to meet global industry challenges.

Pattern Drafting Skills

Pattern drafting skills in garment construction are assessed through students' ability to integrate the functions of tools with systematic work processes, thereby translating abstract designs into high-quality physical products. The use of measuring tools such as flexible tapes and L-squares ensures accurate body dimensions, while shaping tools such as French curves and hip curves enable the creation of smooth and ergonomic pattern lines [32]. In addition, the application of marking tools such as mechanical pencils, tracing wheels, and awls enhances technical communication during the cutting and sewing processes [40]. Students are also required to apply a systematic workflow that begins with taking body measurements, constructing basic patterns, manipulating darts and flares, and completing pattern labelling, followed by toile testing to minimise errors and material waste [4,10]. The application of drape concepts and fabric stretch allows students to adapt patterns according to the mechanical properties of materials, including the calculation of ease and negative ease for knitted fabrics [18]. Knowledge of grain direction and fabric patterns ensures garment stability and aesthetic value, while drafting techniques based on fabric weight and thickness enhance comfort and accuracy in the final product [40]. The integration of digital systems such as Computer-Aided Design (CAD) enables students to perform 3D simulations, automated calculations, and faster design adjustments, while still maintaining the importance of manual skills [3,5,32]. Overall, a high level of pattern drafting skills is achieved through the combined application of tool usage, understanding of fabric properties, systematic work processes, and the integration of digital technology, thereby producing competent and creative students who are well-prepared to meet the challenges of the fashion industry.

Relationship between Knowledge and Mastery of Calculation Techniques in Garment Pattern Making

Garment pattern production requires the integration of theoretical knowledge and technical precision, whereby students' level of knowledge serves as a fundamental basis for mastering calculation techniques. Knowledge of tools, terminology, and methods enables students to accurately translate anthropometric measurements into calculation formulas, thereby enhancing efficiency in the pattern drafting process [32]. In this context, mastery of calculation techniques extends beyond mathematical skills, as it is also influenced by an understanding of body structure, proportions, and scale, all of which affect garment comfort and functionality [40]. Furthermore, the incorporation of ethnomathematical elements in traditional patterns demonstrates that knowledge of geometry and symmetry can strengthen students' ability to perform calculations in a more systematic manner [27]. However, such mastery is often influenced by cognitive load, where well-organised knowledge within cognitive structures enables students to process information more efficiently [17]. In addition, factors such as self-efficacy and mathematics anxiety play a significant role, as strong foundational knowledge can enhance students' confidence and reduce errors in calculations. Overall, the literature suggests that mastery of calculation techniques in garment pattern production depends on the strength of foundational knowledge that supports the accurate, systematic, and effective application of mathematical principles.

Relationship between the Level of Pattern Drafting Skills and Mastery of Calculation Techniques in Garment Pattern Making

Pattern drafting skills serve as a bridge between theory and practice in garment pattern production, where mastery of calculation techniques can only be strengthened through accurate practical application. Textile calculations involving measurements and pattern formation require a high level of precision to avoid sizing errors and material wastage [10]. Continuous drafting practice through Technical and Vocational Education and Training (TVET) approaches and the cognitive apprenticeship model helps students reinforce calculation skills through hands-on experience, while also enhancing spatial visualisation abilities in translating measurements into physical patterns [45]. In addition, the use of Computer-Aided Design (CAD) improves the accuracy of calculations through digital support; however, fundamental mathematical skills remain essential to ensure accurate data input [7]. From a sustainability perspective, zero-waste pattern drafting techniques require more precise calculations to optimise fabric utilisation. Furthermore, instructional materials such as video tutorials and interactive e-modules strengthen students' understanding of calculation procedures in a systematic manner [39,46]. Overall, the literature indicates that strong pattern drafting skills directly enhance the mastery of calculation techniques through the integration of practical training, spatial visualisation, and digital technology.

3. Methodology

This study employed a quantitative approach grounded in the positivist paradigm to collect and analyse data objectively, aiming to measure students' knowledge and calculation skills through precise numerical data [13]. To support this approach, a survey design was selected as it enables systematic and efficient data collection on a large scale, while allowing for the analysis of complex relationships among students' knowledge, pattern drafting skills, and mastery of calculation techniques [2]. The effectiveness of the survey design in the context of Technical and Vocational Education and Training (TVET) has been demonstrated in studies examining the correlation between students' mathematical knowledge and their practical performance in garment pattern drafting. Additionally, this design is flexible within the sub-discipline of mathematics education, allowing for the analysis of cognitive factors influencing the quality of technical products produced [15]. Data were collected using standardised instruments and analysed using SPSS to perform correlation and regression analyses, thereby generating scientific conclusions that can be generalised and providing recommendations for improving the TVET education system [13].

Population and Samples

The study population refers to all students actively enrolled in the Home Economics Education (HEE) programme at Universiti Pendidikan Sultan Idris (UPSI), Malaysia, totalling 142 individuals. These students have undergone learning that integrates garment pattern production techniques with basic mathematical calculations, making them relevant to the objectives of this study [13]. The selection of this population is further supported by UPSI's reputation in providing a conducive vocational learning ecosystem for examining the relationship between cognitive dimensions and technical skill performance [13]. To ensure fair representation of the data, the study employed stratified random sampling based on semester of study, with the aim of minimising selection bias and enhancing the reliability and generalisability of the findings [34]. The sample selection criteria emphasised students' active participation, background in pattern drafting techniques and

mathematical calculations, as well as voluntary consent, in order to ensure both the quality and ethical integrity of the data collection process [38]. The sample size was determined based on the Krejcie and Morgan (1970) table, which suggested 103 respondents, with an additional 20% included as a buffer, resulting in a target sample size of 124 respondents. This approach was adopted to ensure adequate statistical power and robustness of analysis using SPSS [8].

Instruments

The primary instrument of this study was a systematically developed questionnaire designed to collect quantitative data from respondents, encompassing demographic profiles, levels of mathematical knowledge, conceptual pattern-drafting skills, and mastery of calculation techniques in garment pattern drafting. The questionnaire employed a closed-ended format using a five-point Likert scale, allowing respondents to express their level of agreement objectively, thereby generating interval-level data suitable for inferential analysis [25]. The instrument was divided into four main sections: Section A for respondent information, Section B for mastery of calculation techniques, Section C for knowledge, and Section D for pattern-drafting skills. Each section was carefully designed to ensure comprehensive measurement of the constructs under study [2]. Section B assessed mathematical competence in pattern drafting, Section C evaluated understanding of fundamental concepts and the use of tools, while Section D measured pattern-drafting skills by examining the application of theoretical knowledge into practical tasks through the use of formulas, drafting tools, and pattern manipulation techniques [32]. Each section of the instrument was systematically structured to produce consistent data that could be analysed using SPSS, while ensuring content validity through accurate measurement of the intended constructs [38].

Data Analysis

Data analysis in this study was conducted to transform raw questionnaire data into meaningful information for empirically addressing the research questions, using the latest version of SPSS 27.0 [11]. Prior to analysis, data cleaning and coding procedures were carried out to ensure that respondents' responses were accurately converted into numerical form, thereby minimising errors during statistical computation. This step was critical in ensuring data integrity and the reliability of the findings, as well as providing a solid foundation for subsequent analysis. Descriptive analysis was employed to describe the demographic profile of respondents, including gender and semester of study, as well as to compute mean scores and standard deviations for the main variables, namely knowledge level, pattern-drafting skills, and mastery of calculation techniques. This process enabled the researchers to objectively identify respondents' tendencies and assess general performance patterns in garment pattern production [35]. The results of the descriptive analysis also provided initial insights into performance differences based on demographic characteristics prior to conducting inferential analysis. Inferential analysis was conducted using the Pearson Correlation test to examine the direction and significance of the linear relationship between students' mathematical knowledge and their mastery of calculation techniques. Prior to performing this test, the researchers ensured that the data met the assumptions of parametric statistics, such as normality, to guarantee the validity of the analysis [13,19]. Overall, the data analysis procedures enabled the findings to be presented in a scientific, detailed, and systematic manner, thereby supporting improvements in teaching methodologies within technical and vocational education [38].

4. Result and Discussion

Mastery of Calculation Techniques

The findings of the study indicate that students' mastery of calculation techniques is at a high level (M = 3.57, SD = 0.76), thereby supporting the importance of fundamental mathematical competence in garment pattern production, as highlighted in previous studies. High mastery in routine skills such as unit conversion (M = 3.71) and body measurement division (M = 3.61) reflects students' ability to apply basic mathematical skills, including division, proportion, and unit conversion. These findings are consistent with the views of Lee and Choi [26] and Chattopadhyay *et al*., [10], who emphasised that strong foundational mathematical knowledge is a crucial prerequisite for ensuring accuracy in garment structure and pattern fitting. However, the findings also reveal that aspects involving pattern evaluation and modification recorded the lowest mean score (M = 3.42), indicating that students still face challenges in higher-order thinking skills, particularly in spatial reasoning and the application of more complex geometric concepts. This observation supports the findings of Tee *et al*., [45], who asserted that spatial visualisation skills and geometric understanding are essential for enabling students to visualise the relationship between two-dimensional forms and the human body structure. Weaknesses in this aspect may affect students' ability to produce balanced and accurate patterns, as highlighted by Qiao [37] and Kamis *et al*., [24] regarding the importance of symmetry in ensuring visual balance in garment design. Furthermore, although students demonstrated good mastery of basic skills, these findings confirm that mastery of calculation techniques extends beyond routine procedures and requires the integration of analytical, spatial, and adaptive skills. This is consistent with the findings of Jin *et al*., [23], who emphasised that while technologies such as Computer-Aided Design (CAD) can enhance accuracy, a strong foundation in mathematics remains essential for evaluating and refining pattern outcomes. Overall, the findings of this study reinforce the existing literature that mastery of calculation techniques is a fundamental component in garment pattern production. However, greater emphasis should be placed on the development of spatial reasoning and higher-order thinking skills to ensure that students are able to meet the increasingly complex and sustainable demands of the fashion industry [43].

Level of Knowledge

The findings of the study indicate that students' level of knowledge is high (M = 3.57), with excellent mastery of fundamental concepts such as pattern markings (M = 4.08) and basic pattern terminology (M = 3.94). These findings confirm that theoretical mastery serves as a crucial foundation before students are able to apply skills in practical contexts, consistent with the cognitive hierarchy which emphasises progression from knowledge to application. This level of competence also suggests that students have developed strong knowledge "schemas" in their long-term memory, thereby facilitating the execution of practical tasks with reduced cognitive load. The findings are consistent with the study by Amalia and Irmayanti [4], which emphasises that fundamental pattern knowledge is a core component of fashion education, as it provides the technical framework for all design processes. Mastery of concepts such as slopers and pattern terminology enables students to apply creativity in producing functional garments, whereas a lack of such knowledge may result in patterns that are not ergonomically appropriate [39]. In addition, a high level of knowledge supports students' abilities in spatial visualisation and understanding of pattern structure. This is consistent with the findings of Bilqis and Arifiana [9] and Tee *et al*., [45], which indicate that mastery of geometric concepts and spatial reasoning enables students to more accurately visualise the transformation of

patterns from two-dimensional forms into three-dimensional structures. Anthropometric knowledge also plays a crucial role in ensuring garment fit and comfort, as highlighted by Abu Na and Faraj [1]. From a pedagogical perspective, the findings further support the importance of incorporating interactive media in teaching. Studies by Wati *et al*., [46] and Muhamil *et al*., [33] demonstrate that the use of e-modules, video tutorials, and creative instructional tools can enhance student engagement and strengthen understanding of fundamental concepts. In addition, the integration of technologies such as Computer-Aided Design (CAD) facilitates pattern visualisation and simulation processes; however, it still requires a strong foundation in manual knowledge to be used effectively [7]. Overall, these findings reinforce the literature that a high level of knowledge not only supports the application of practical skills but also serves as a foundation for developing competent fashion students through the integration of creativity, technical accuracy, and technological adaptability.

Level of Pattern Drafting Skills

The findings of the study indicate that students' pattern drafting skills are at a high level (M = 3.74), reflecting their ability to apply knowledge and skills practically in garment pattern production. This high level of achievement, particularly in the use of scaled patterns as a guide (M = 3.88), suggests that students have mastered the fundamentals of a systematic workflow in pattern drafting. These findings are consistent with the study by Mehta and Shah [32], which emphasises that the use of appropriate tools such as measuring tapes, L-squares, and French curves contributes to dimensional accuracy and the production of ergonomic patterns. In addition, students' ability to carry out the drafting process in a sequential manner reflects their mastery of a systematic workflow, beginning from body measurement to the development of basic patterns. This supports the findings of Chattopadhyay *et al*., [10] and Amalia and Irmayanti [4], who emphasised that effective pattern drafting requires structured work procedures to minimise errors and material wastage. Furthermore, the application of marking tools and pattern labelling techniques enhances technical communication in the garment production process [40].

However, the findings indicate that skills requiring a high level of precision, such as drafting the front armhole curve, recorded the lowest mean score (M = 3.53). This suggests that students still face challenges in managing complexity and achieving high accuracy, particularly in tasks involving curves and shape adjustments. This issue is closely related to the need for understanding fabric properties and concepts such as drape, elasticity, and pattern balance, as highlighted by Habib and Alam [18]. From a pedagogical perspective, these findings also support the principles of Cognitive Apprenticeship, which emphasise learning through structured hands-on practice and repetition to develop psychomotor skills. However, as noted by Aizudin *et al*., [3], mastery of practical skills must be supported by strong theoretical understanding and the integration of technologies such as Computer-Aided Design (CAD) to enhance accuracy and efficiency. Overall, the findings reinforce the literature that high-level pattern drafting skills are the result of integrating appropriate tool usage, systematic workflow implementation, understanding of material properties, and technological support. Nevertheless, continuous emphasis on precision and technical reasoning is required to ensure that students are capable of handling more complex tasks and meeting the dynamic demands of the fashion industry. Table 1 indicate the summary for Objectives 1, 2 and 3.

Table 1
Summary for objectives 1, 2 and 3

Objectives	**Correlation value (*r*)**
Obj 1 : To identify the level of mastery of calculation techniques in garment pattern making.	M= 3.57, SD = 0.76 (Moderate)
Obj 2 : To identify the level of knowledge and pattern drafting skills in garment pattern making.	M= 3.57, SD = 0.76 (Moderate)
Obj 3 : To identify the level of pattern drafting skills in garment pattern making.	M= 3.74, SD = 0.79 (High)

Relationship between Knowledge and Mastery of Calculation Techniques in Garment Pattern Making

The findings of the study indicate a strong and significant positive relationship between students' level of knowledge and mastery of calculation techniques ($r = 0.767$, $p < .005$), thereby demonstrating that theoretical mastery directly enhances procedural efficiency in garment pattern production. This finding is consistent with John R. Anderson's (1983) theory, which posits that learning begins with declarative knowledge before progressing to procedural skills. Understanding fundamental concepts such as pattern markings functions as a "schema" in long-term memory, enabling students to perform calculations more accurately and systematically. These findings also support the literature which emphasises that knowledge of tools, terminology, and techniques enables students to translate anthropometric measurements into accurate calculation formulas [32], while also applying concepts of proportion and body structure more effectively [40]. In addition, understanding geometry and symmetry further strengthens systematic calculation abilities [27], whereas well-structured knowledge helps reduce cognitive load and improves information processing efficiency [17]. Overall, these findings affirm that foundational knowledge is a crucial prerequisite for ensuring accuracy and effectiveness in the application of calculation techniques in garment pattern production.

Relationship between the Level of Pattern Drafting Skills and Mastery of Calculation Techniques in Garment Pattern Making

The findings of the study indicate a strong and significant positive relationship between pattern drafting skills and mastery of calculation techniques ($r = 0.765$, $p < .005$), demonstrating that improvements in practical drafting skills directly enhance students' computational proficiency. These findings are consistent with Mehta and Shah [32], who emphasised that consistent hands-on practice and the correct use of drafting tools contribute to the development of strong technical skills, particularly in translating linear measurements into physical pattern forms. This relationship also confirms that mastery of calculation techniques does not occur in isolation but is developed through the integration of knowledge and psychomotor skills within the pattern drafting process. Furthermore, the findings support existing literature that pattern drafting skills function as a bridge between cognitive theory and practical application, where the accuracy of calculations can only be validated through actual implementation in workshop settings [10]. In addition, training approaches based on Technical and Vocational Education and Training (TVET) and the cognitive apprenticeship

model further strengthen students' spatial visualisation abilities, thereby improving accuracy in translating anthropometric measurements into precise patterns [45].

In addition, the use of Computer-Aided Design (CAD) technology supports the accuracy and consistency of calculations through digital assistance; however, a strong foundation in mathematics remains essential to ensure correct data input and size grading [7]. In the context of sustainability, the zero-waste pattern drafting approach requires a higher level of precision in calculations to optimise fabric usage and minimise waste. Overall, these findings reinforce the literature that strong pattern drafting skills not only enhance psychomotor efficiency but also strengthen mastery of calculation techniques through the integration of practical training, spatial visualisation, digital technology, and structured learning, ultimately producing more competent students who are better prepared to meet the demands of the fashion industry. Table 2 indicate the summary for Objectives 3 and 4.

Table 2
Summary for correlations between the variables

Objectives	Correlation value (*r*)	Sig value (p)
Obj 3 : To analyse the relationship between the level of knowledge and mastery of calculation techniques in garment pattern making.	.767**	<.005
Obj 4 : To analyse the relationship between the level of pattern drafting skills and mastery of calculation techniques in garment pattern making.	.765**	<.005

5. Conclusion

Overall, this study indicates that students' mastery of calculation techniques in garment pattern production is at a level that requires improvement, particularly in the accurate application of calculations during the drafting process. The findings suggest that some students still experience difficulties in linking mathematical concepts with practical implementation in garment pattern construction. For the second objective, the study found that students' levels of knowledge and pattern drafting skills are moderate to good; however, they still require strengthening through continuous practice and exposure to more systematic drafting methods. For the third objective, the analysis revealed a strong and significant positive relationship between knowledge and pattern drafting skills and mastery of calculation techniques, confirming that improvements in drafting skills directly contribute to enhanced computational proficiency. In conclusion, the integration of theoretical knowledge, practical skills, and structured training is essential in strengthening overall mastery of garment pattern production skills among fashion students.

6. Implication

Based on the findings of this study, there is a need to shift the teaching paradigm from a traditional linear approach to a more holistic and integrated contextual learning approach. Mastery of calculation techniques is shown to be highly dependent on the integration of theory and practice; therefore, teaching and learning sessions should not be conducted in isolation. Educators should explicitly integrate mathematical elements such as geometry, ratios, and spatial transformations into every pattern drafting activity so that students can connect abstract concepts with the physical forms

of garments. In addition, progressive scaffolding strategies and the use of the Cognitive Apprenticeship model supported by interactive e-modules and video tutorials should be expanded to help students develop independent understanding through the process of "making thinking visible," thereby reducing cognitive load and enhancing comprehension of complex computational concepts. Furthermore, the curriculum for Home Economics and Technical and Vocational Education and Training (TVET) should be reviewed to ensure a balanced integration of sewing skills, pattern drafting, and applied mathematics. Emphasis on "The Essential Triad" tools, terminology, and techniques should be established as a foundational competency before students progress to industry-level practice. Strengthening manual skills should also be prioritised before exposure to Computer-Aided Design (CAD) technology to ensure that students do not become overly dependent on automation, but instead are able to evaluate the accuracy of their work based on fundamental pattern drafting principles. Overall, this study highlights that mastery of calculation techniques is an important transferable skill, where the integration of intellectual knowledge and systematic practical training not only enhances student competence and professionalism but also supports sustainability practices through fabric waste reduction and the development of a globally competitive and skilled workforce.

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Conflict of Interest
The authors declare that there is no conflict of interest.

Data and Material Availability
Data are available upon request from the authors.

Declaration on Generative AI
The authors declare that there was no use of generative AI in writing this article.

Ethics Statement
Not applicable.

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