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Development of Interactive Digital Learning Materials for the Textile Technology Course

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ABSTRACT

This study aimed to develop a valid Textile Technology learning e-module. The research employed a research and development (R&D) approach, focusing on the development of a Textile Technology learning e-module product. The development model applied in this study was the Instructional Development Institute (IDI) model. The research subjects consisted of FT Unimed students enrolled in the Textile Technology course. Data were collected using a questionnaire, while descriptive data analysis was employed to determine the feasibility of the Textile Technology e-module. The findings revealed that: (1) a Textile Technology learning e-module was successfully developed, and (2) the developed e-module was categorized as highly valid in terms of material aspects (0.90) and format aspects (0.82). Based on these findings, it can be concluded that the Textile Technology e-module is feasible for use as a learning module in Textile Technology courses at the higher education level.

INTRODUCTIONS

The advancement of science, technology, and the creative industry in the digital era has significantly transformed various sectors, including higher education and the fashion industry. Digital transformation in the era of the Fourth Industrial Revolution has encouraged higher education institutions to produce graduates who possess not only academic competencies but also professional skills that are relevant to industrial demands and global technological developments (Bates, 2022). In the context of higher education, learning is no longer limited to theoretical mastery but must also emphasize the development of practical skills, critical thinking, problem-solving abilities, technological literacy, creativity, and self-directed learning to support graduates' readiness for the workforce (Branch, 2019). Therefore, higher education institutions are required to establish innovative, flexible, and technology-based learning systems to improve learning effectiveness and graduate quality.

In fashion education, the rapid development of the fashion and textile industries requires graduates to possess competencies that extend beyond the aesthetic aspects of fashion design to include a comprehensive understanding of textile materials and manufacturing processes. The modern fashion industry continues to evolve through

innovations such as *smart textiles*, *functional textiles*, *wearable technology*, and *sustainable fashion*, which emphasize functionality, efficiency, comfort, and environmental sustainability (Glogar et al., 2025; Jang et al., 2025). These developments indicate that understanding textile technology has become increasingly essential in fashion education, enabling students to comprehend the relationship between textile material characteristics and the quality and functionality of fashion products.

In response to industrial developments and competency demands, Fashion Education Study Programs in higher education institutions have implemented curriculum adjustments through the Curriculum Revitalization of Indonesian Fashion Education (PTTBI/APTTBI). The curriculum revitalization aims to strengthen the alignment between graduate learning outcomes, industrial needs, technological advancements, and twenty-first-century competencies. One of the major changes introduced through this revitalization is the inclusion of the Textile Technology course as a newly introduced course within the Fashion Education curriculum. The introduction of this course is intended to equip students with a comprehensive understanding of textile fibers, yarns, fabric structures, fabric formation processes, dyeing, printing, finishing, and textile quality testing as fundamental knowledge supporting fashion design and garment production.

As a newly introduced course, Textile Technology holds a strategic role in providing students with fundamental knowledge regarding textile materials used in fashion products. The selection of appropriate textile materials significantly affects product quality, functionality, comfort, durability, and aesthetic value (Jang et al., 2025). Therefore, mastery of Textile Technology is not only an academic requirement but also a professional competency that must be possessed by students in Fashion Education programs to meet industrial challenges.

However, the implementation of the Textile Technology course still faces several challenges in the learning process. Based on preliminary observations conducted among students in the Fashion Education Study Program, Faculty of Engineering, Universitas Negeri Medan, it was found that no instructional materials had been specifically developed for the Textile Technology course, considering that this course is a newly introduced subject resulting from the PTTBI curriculum revitalization. The learning process continues to rely on general learning resources, including textbooks and simple presentation media, which have not been specifically designed according to the *Course Learning Outcomes* (CLOs) and the characteristics of Fashion Education students. Consequently, the learning process has not yet been optimally implemented to support students' comprehensive understanding of the subject matter.

The limited availability of instructional materials has contributed to students' difficulties in understanding Textile Technology content, which is technical, abstract, and complex in nature. Topics such as fiber processing, yarn formation, fabric construction, dyeing techniques, printing, and textile finishing require concrete and systematic visualization to enable students to understand the relationship between concepts and processes comprehensively. However, the predominance of text-based conventional instructional materials often limits students' understanding of textile processes in a visual and practical manner. Mayer (2021) explains that learning becomes more effective when information is delivered through an integration of verbal and visual representations rather than through textual explanations alone. Therefore, Textile Technology materials require instructional

media capable of presenting textile processes more concretely to facilitate students' conceptual understanding.

Furthermore, the lack of suitable instructional materials has resulted in students remaining highly dependent on lecturers' explanations during classroom instruction. This condition limits students' opportunities to develop *self-directed learning* skills, despite the fact that higher education requires students to become more active and independent learners. Bates (2022) argues that the integration of digital technology into learning enhances flexibility, expands access to learning resources, and promotes students' active participation in the learning process. Therefore, innovation in technology-based instructional materials has become a critical need in supporting the implementation of the Textile Technology course.

One promising alternative is the development of an interactive e-module. E-modules are electronic instructional materials that integrate various multimedia elements, including text, images, videos, animations, simulations, and learning evaluations into a systematic and easily accessible learning medium (Prastowo, 2018). The implementation of e-modules enables students to learn more flexibly according to their own learning pace and individual needs. Furthermore, e-modules support independent learning through more engaging, interactive, and contextual content delivery.

Previous studies have demonstrated that e-modules contribute positively to learning effectiveness and conceptual understanding across various educational contexts. Saputra et al. (2023) found that *interactive electronic modules* improved student engagement and learning effectiveness. Haryanti et al. (2025) reported that digital e-modules enhanced project-based learning quality and helped students understand learning materials more systematically. Palinussa et al. (2025) also revealed that e-modules positively influenced students' learning outcomes through interactive material presentation. Similarly, Utami et al. (2025) found that content quality, usability, and the effectiveness of e-modules significantly improved students' learning experiences in higher education.

Other studies have also demonstrated the effectiveness of digital instructional materials. Sholihah et al. (2023) found that curriculum-based e-module development improved learning flexibility and facilitated students' contextual understanding of subject matter. Kurniawan et al. (2025) reported that project-based e-modules positively influenced students' responses to learning activities. Furthermore, Mazidah et al. (2025) emphasized that integrating digital technology into instructional media increased student engagement and enhanced learning effectiveness. These findings indicate that interactive digital instructional materials possess substantial potential to improve the quality of higher education learning.

Despite the demonstrated effectiveness of e-modules in supporting learning, the development of e-modules specifically designed for the Textile Technology course as a newly introduced course resulting from the PTTBI curriculum revitalization remains highly limited. Most previous studies have focused on general education, primary education, or other disciplines and have not specifically addressed the characteristics of Textile Technology materials, which require extensive visualization, procedural understanding, and strong connections between theoretical concepts and industrial practices. Moreover, no interactive digital instructional material has been specifically designed based on the characteristics of students in the Fashion Education Study Program and the learning outcomes of the Textile Technology course at the Faculty of Engineering, Universitas Negeri Medan. Therefore, a research gap exists concerning the limited development of interactive

digital instructional materials for Textile Technology as a newly introduced course in higher education.

Based on these considerations, this study was conducted to develop an interactive digital instructional material for the Textile Technology course using the *Instructional Development Institute* (IDI) model. The IDI model was selected because it provides systematic development stages through the *define*, *develop*, and *evaluate* phases, enabling products to be developed according to learning needs and validated before implementation (Branch, 2019; Sugiyono, 2017). The novelty of this study lies in the development of a Textile Technology e-module specifically designed to support the implementation of a newly introduced course resulting from the PTTBI curriculum revitalization, aligned with the characteristics of Fashion Education students and integrated with interactive multimedia elements. Therefore, the developed e-module is expected to address the limitations of instructional materials, improve students' understanding of Textile Technology concepts, and support more flexible, interactive, and student-centered learning in higher education.

Based on the aforementioned considerations, this study aims to develop an interactive digital instructional material for the Textile Technology course that is valid and feasible for implementation as a learning medium in the Fashion Education Study Program, Faculty of Engineering, Universitas Negeri Medan.

RESEARCH METHOD

This study employed a Research and Development (R&D) approach aimed at producing a Textile Technology e-module that is valid and feasible for implementation in higher education learning. The Research and Development method was selected because this type of research not only focuses on examining educational phenomena but also generates educational products that can be utilized to support the learning process. Research and development is considered a systematic approach used to design, develop, and validate educational products in accordance with users' learning needs (Branch, 2019; Sugiyono, 2017).

The development model adopted in this study was the *Instructional Development Institute* (IDI) model. The IDI model was selected because it provides systematic, practical, and educationally relevant stages for the development of digital instructional media. The model consists of three main stages: *define* (needs assessment), *develop* (development), and *evaluate* (evaluation), which enable the product to be systematically developed based on identified learning needs and validated prior to implementation (Branch, 2019).

This study was conducted in the Fashion Education Study Program, Faculty of Engineering, Universitas Negeri Medan (UNIMED). The subjects of the study consisted of students enrolled in the Textile Technology course, while the object of the study was the development of a Textile Technology e-module designed based on the *Course Learning Outcomes* (CLOs).

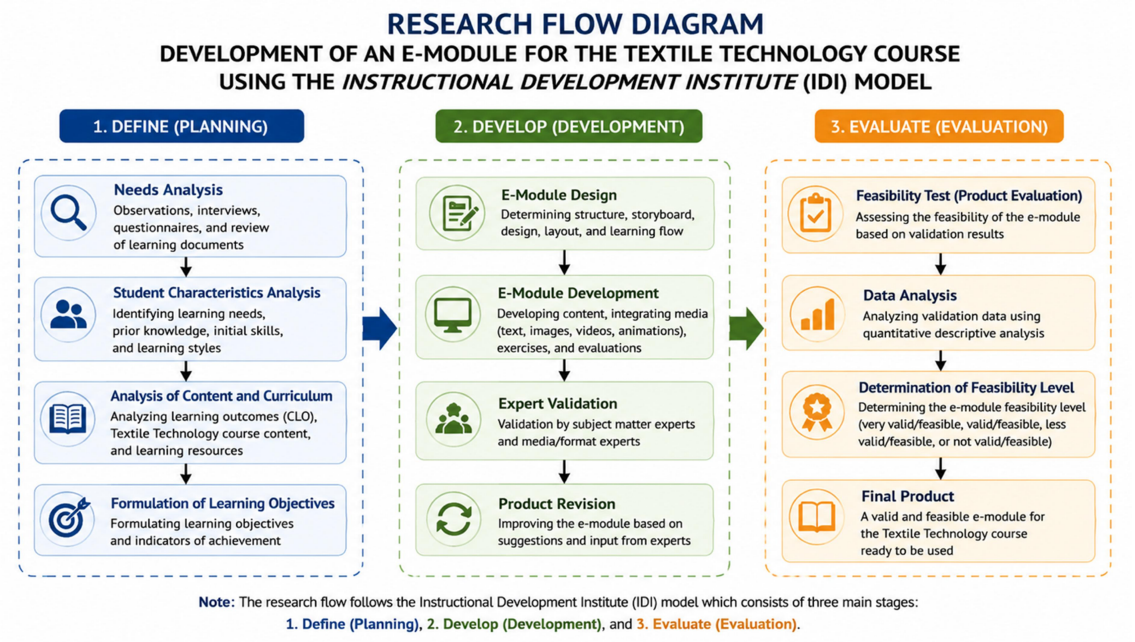

Figure 1. Research Flow Diagram

Define Stage

The *define* stage represented the initial phase of the study, aiming to identify learning needs as the foundation for developing the Textile Technology e-module. At this stage, a series of analyses was conducted to obtain a comprehensive understanding of learning conditions, student characteristics, instructional material needs, and the alignment between course content and learning outcomes.

The first activity undertaken was a needs analysis, which involved preliminary observations, reviews of learning documents, and the identification of problems encountered in the Textile Technology learning process within the Fashion Education Study Program, Faculty of Engineering, Universitas Negeri Medan. The findings indicated that the learning process was still predominantly supported by conventional instructional materials, such as textbooks and simple presentation media, causing students to experience difficulties in understanding technical and abstract subject matter. These findings indicate the necessity for instructional innovation capable of facilitating more visual, systematic, and contextual learning through the integration of digital media (Bates, 2022; Mayer, 2021).

Subsequently, a student characteristics analysis was conducted to identify students' prior knowledge, learning needs, and learning styles related to the Textile Technology course. This analysis aimed to ensure that the developed e-module would be aligned with learners' characteristics, thereby improving learning effectiveness and supporting students' independent learning (Prastowo, 2018).

The next step involved a content and curriculum analysis, including the examination of the *Course Learning Outcomes* (CLOs), Textile Technology course materials, and the learning resources used. This analysis was carried out to ensure that the content included in the e-module was aligned with the curriculum and competency requirements of students in the Fashion Education Study Program. Based on the findings, learning objectives were

formulated to serve as the basis for organizing the content, structure, and evaluation components of the Textile Technology e-module (Sugiyono, 2017; Branch, 2019).

Develop Stage

The *evaluate* stage represented the final phase of the IDI development model, aiming to determine the feasibility level of the developed Textile Technology e-module. The evaluation was conducted based on expert validation results concerning both content and format aspects of the e-module. This evaluation process ensured that the e-module met the required standards in terms of content appropriateness, media quality, and alignment with students' learning needs (Azwar, 2014; Sugiyono, 2017).

Table 1. Validation Criteria for E-Module Content

Aspect	Assessment Indicators
E-Module Content	a) Alignment of content with *Course Learning Outcomes* (CLOs) b) Accuracy of conceptual content c) Quality of instructional content d) Clarity of language

Table 2. Validation Criteria for E-Module Format

Aspect	Assessment Indicators
E-Module Format	a) Image quality b) Interface/Layout design c) Functional aspects d) Use of color e) Visual balance

At this stage, a product feasibility assessment was conducted through the analysis of expert validation results to determine the validity level of the developed e-module. The evaluation covered several aspects, including content quality, instructional integration, language clarity, interface design, visual quality, and the ease of use of the e-module by students. The feasibility assessment aimed to ensure that the developed e-module fulfilled learning needs and met the standards of high-quality digital instructional media (Azwar, 2014; Prastowo, 2018).

The validation data were subsequently analyzed using quantitative descriptive analysis. The scores obtained from validators were calculated to determine the validity level of the product according to predefined categories, namely *highly valid*, *valid*, *less valid*, or *invalid*. The findings of the analysis served as the basis for determining the feasibility level of the e-module and revising the product before implementation in the learning process (Sugiyono, 2017; Azwar, 2014).

This stage resulted in the final product in the form of a Textile Technology e-module that was declared valid and feasible for implementation as an instructional resource in the Textile Technology course within the Fashion Education Study Program, Faculty of Engineering, Universitas Negeri Medan. The developed e-module is expected to improve learning quality, facilitate students' understanding of textile technology concepts, and support independent learning through more visual, interactive, and systematic content delivery (Mayer, 2021; Bates, 2022).

Data Analysis Technique

The data analysis technique employed in this study was quantitative descriptive analysis, which aimed to describe the validity level of the developed Textile Technology e-module. Validation data were obtained through assessment questionnaires administered to subject matter experts and media/format experts. The analysis focused on quantitative data derived from the validation process to determine the feasibility level of the e-module prior to its implementation in the learning process. Quantitative descriptive analysis was employed to provide an objective description of the quality of the developed instructional product based on expert evaluation results (Sugiyono, 2017).

The procedures for data analysis in this study were systematically carried out to determine the validity and feasibility level of the developed Textile Technology e-module.

Validity Assessment Scale

The validation instrument employed in this study used a five-point rating scale to measure the appropriateness and feasibility of the developed Textile Technology e-module. The use of this rating scale aimed to obtain objective data regarding the quality of content, design, language, and functionality of the developed digital instructional media (Azwar, 2014). The assessment categories used in this study are presented as follows:

5 = Strongly Agree
4 = Agree
3 = Moderately Agree
2 = Disagree
1 = Strongly Disagree

Table 3. Validity Assessment Criteria

Score	Criteria	Percentage (%)
A	Strongly Agree	90–100%
B	Agree	70–89%
C	Moderately Agree	50–69%
D	Disagree	30–49%
E	Strongly Disagree	0–29%

Source: Adapted from Sugiyono (2017)

Validation Score Calculation

The next step involved calculating the validation scores by summing the assessment scores provided by each validator for all indicators related to both the content and format aspects of the e-module. The obtained scores served as the basis for determining the validity level of the developed learning product. This assessment process aimed to provide an objective description of the e-module quality based on expert evaluations of content, media design, language clarity, and instructional functionality (Azwar, 2014).

Validity Analysis Using Aiken's V

The validation data were subsequently analyzed using the Aiken's V formula to determine the level of agreement among validators regarding the feasibility of the developed e-module. The application of Aiken's V in development research aims to measure content validity based on expert judgment. The Aiken's V formula was employed to determine the

validity level of the developed instructional product in a more objective and systematic manner (Azwar, 2014).

Interpretation of Validity Results

The results of the Aiken's V coefficient range from 0 to 1. The developed e-module is considered valid and feasible for implementation when the validity score is ≥ 0.60, indicating a sufficiently high level of agreement among validators. Therefore, the higher the obtained validity score, the better the feasibility level of the Textile Technology e-module as an instructional medium in higher education. The interpretation of validity results serves as the basis for determining the quality of the developed instructional product prior to its implementation in the learning process (Azwar, 2014).

RESEARCH AND DISCUSSION

Results

The *define* stage was conducted to identify learning needs as the foundation for developing the Textile Technology e-module. At this stage, several analyses were carried out, including learning needs analysis, student characteristics analysis, content analysis, and curriculum analysis implemented in the Textile Technology course within the Fashion Education Study Program, Faculty of Engineering, Universitas Negeri Medan.

The results of preliminary observations indicated that the Textile Technology learning process was still predominantly supported by conventional instructional materials, such as textbooks and simple presentation media. This condition caused students to experience difficulties in understanding technical and abstract subject matter, particularly topics related to textile processing, ranging from fibers, yarns, and fabric construction to textile finishing processes (*finishing*). Furthermore, the findings revealed that no interactive digital instructional materials specifically designed according to the characteristics of the Textile Technology course and the learning needs of Fashion Education students were available. Consequently, students remained highly dependent on lecturers' explanations due to the limited availability of independent learning resources that could be accessed flexibly.

Table 4. Preliminary Observation Results of Textile Technology Learning

No.	Observed Aspect	Observation Results
1	Instructional Materials	Predominantly relied on textbooks and presentation slides
2	Student Understanding	Students experienced difficulties in understanding technical and abstract materials
3	Learning Media	Interactive e-modules were not yet available
4	Learning Independence	Students remained dependent on lecturers' explanations
5	Material Visualization	Learning materials had not been optimally visualized

Source: Preliminary Observation Data (2025)

Based on the findings of the analysis, there is a need for innovation in digital-based instructional materials that can assist students in understanding Textile Technology content more visually, systematically, and flexibly. Therefore, an e-module for the Textile Technology course was developed as a solution to support students' independent learning.

Develop Stage

The *develop* stage involved the process of designing and developing the Textile Technology e-module based on the results of the needs analysis conducted in the previous stage. The development process was carried out by considering the course learning outcomes, student characteristics, and the principles of digital instructional material development.

Table 5. Components of the Textile Technology E-Module

No.	E-Module Component	Description
1	Learning Materials	Textile Technology materials aligned with the *Course Learning Outcomes* (CLOs)
2	Visual Media	Illustrative images of textile processes
3	Learning Evaluation	Practice exercises and assessments
4	Interface Design	Layout, color scheme, and e-module navigation

Source: Research Data (2025)

The developed e-module contained Textile Technology learning materials presented systematically, including fundamental concepts of textile fibers, yarns, fabric construction, textile manufacturing processes, textile finishing, and the applications of textiles in fashion. To support students' understanding, the e-module was complemented with illustrative images, practice exercises, learning assessments, and activities that facilitated independent learning.

In addition to content development, attention was also given to the interface design of the e-module to ensure that it was attractive and user-friendly for students. The interface was designed by considering aspects such as readability, layout organization, visual quality, and navigation to enhance the overall learning experience.

Figure 2. E-Module Interface

The development process resulted in a prototype of the Textile Technology e-module, which was subsequently subjected to a validation stage to determine the feasibility level of the product prior to its implementation in the learning process.

Evaluate Stage

The *evaluate* stage was conducted through a product validation process involving subject matter experts and media/format experts to determine the feasibility level of the developed e-module. The validation process aimed to assess the appropriateness of the e-module based on several evaluation aspects.

The content validation covered the alignment of materials with the intended learning outcomes, content quality, systematic organization, and language clarity. Meanwhile, the format validation focused on image quality, interface design, functionality, color usage, and overall visual balance of the e-module.

Table 6. Validation Results of the Textile Technology E-Module

No.	Evaluation Aspect	Validity Score	Category
1	E-Module Content	0.90	Highly Valid
2	E-Module Format	0.82	Highly Valid
Average		**0.86**	**Highly Valid**

Source: Validation Data (2025)

The validation results indicated that the content aspect achieved a validity score of 0.90, while the format aspect obtained a score of 0.82. Both aspects were categorized as highly valid. These findings demonstrate that the developed Textile Technology e-module met the required standards of validity and feasibility to be implemented as an instructional resource in the Textile Technology course within the Fashion Education Study Program, Faculty of Engineering, Universitas Negeri Medan.

The high level of validity suggests that the developed e-module fulfilled the criteria of effective instructional materials in terms of content relevance, instructional quality, and media design. Furthermore, the integration of multimedia elements within the e-module provided a more engaging and interactive learning experience for students. Consequently, the developed e-module has the potential to enhance learning effectiveness and foster students' independent learning

DISCUSSION

The findings of this study demonstrated that the Textile Technology e-module developed using the *Instructional Development Institute* (IDI) model achieved a high level of validity in both content and format aspects. Based on the validation results, the content aspect obtained a validity score of 0.90, while the format aspect achieved a score of 0.82, both categorized as highly valid. These findings indicate that the developed e-module met the required standards of validity and feasibility for implementation in the Textile Technology course within the Fashion Education Study Program, Faculty of Engineering, Universitas Negeri Medan.

The findings at the *define* stage revealed that the learning process of Textile Technology still encountered several challenges, particularly the limited availability of interactive instructional materials aligned with students' characteristics and learning needs. The learning process remained predominantly dependent on textbooks and simple presentation media, resulting in difficulties for students in understanding technical and abstract concepts, including spinning, weaving, fabric formation, and textile finishing processes. This finding highlights the need for digital instructional materials capable of

facilitating students' understanding through more visual, systematic, and contextual learning experiences.

These findings are consistent with the perspective of Mayer, who argued that multimedia-based learning enhances conceptual understanding through the integration of text, images, and visual representations that support students' cognitive processes. In the context of Textile Technology, visual representation becomes particularly important because much of the learning material involves technical concepts that are difficult to comprehend when delivered solely through verbal explanations or textual descriptions.

At the *develop* stage, the e-module was systematically designed to include Textile Technology materials covering textile fibers, yarns, fabric construction, textile manufacturing processes, and textile finishing, as well as their applications in fashion. Furthermore, the e-module was complemented with visual elements, learning evaluations, and interactive features to support students' independent learning. The development of digital instructional materials such as e-modules provides flexibility in learning, enabling students to access learning materials anytime and anywhere according to their individual learning needs and pace.

The high validity score of the content aspect (0.90) indicates that the e-module content was aligned with the *Course Learning Outcomes* (CLOs), demonstrated conceptual accuracy, contained high-quality instructional content, and employed language that was comprehensible to students. These findings suggest that the developed content fulfilled the principles of effective instructional material development. According to Prastowo, effective instructional materials should be systematically organized, aligned with learning objectives, easily comprehensible, and capable of supporting students' independent learning.

Meanwhile, the format aspect, which achieved a validity score of 0.82, demonstrated that the e-module possessed an effective visual design, including image quality, layout organization, functionality, color usage, and visual balance. The visual aspect plays a crucial role in digital learning media because it influences readability, student engagement, and learning motivation. This finding is supported by Daryanto, who emphasized that effective instructional media should attract learners' attention, facilitate understanding of concepts, and encourage active participation in the learning process.

The findings of this study further reinforce the effectiveness of the *Instructional Development Institute* (IDI) model in producing feasible and valid instructional products. The systematic stages of the IDI model—*define*, *develop*, and *evaluate*—enabled the development process to be conducted in a structured manner, ensuring that the resulting product aligned with students' learning needs. The evaluation stage, carried out through expert validation, also provided opportunities for product refinement before implementation in the learning process.

Overall, the findings indicate that the Textile Technology e-module developed through the IDI model has the potential to improve learning effectiveness, strengthen students' conceptual understanding, and support independent learning in higher education. Therefore, the developed e-module may serve as an innovative digital instructional resource that contributes to more flexible, interactive, and student-centered learning in the Fashion Education Study Program.

CONCLUSION

This study resulted in the development of a Textile Technology e-module using the *Instructional Development Institute* (IDI) model, which consisted of three stages: *define* (needs assessment), *develop* (development), and *evaluate* (evaluation). At the *define* stage, the findings revealed that Textile Technology learning still faced limitations in terms of interactive instructional materials, leading to students' difficulties in understanding technical and abstract subject matter. Therefore, the developed e-module was intended to provide a more systematic, visual, and accessible digital instructional resource to support the learning process.

The findings further demonstrated that the developed Textile Technology e-module met the required feasibility standards based on expert validation results. The content aspect achieved a validity score of 0.90, categorized as highly valid, while the format aspect obtained a score of 0.82, also categorized as highly valid. With an overall average validity score of 0.86, the developed e-module was considered feasible for implementation as an instructional resource in the Textile Technology course within the Fashion Education Study Program, Faculty of Engineering, Universitas Negeri Medan.

Based on the findings, it can be concluded that the development of a Textile Technology e-module using the IDI model successfully produced a digital instructional material that is valid, systematic, and aligned with the learning needs of higher education. The developed e-module is expected to enhance students' understanding of Textile Technology concepts and support a more flexible, interactive, and student-centered learning process.

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