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The Role of Industrial Internship Programs on Professional Learning and Industry Awareness in Furniture Design Education

Nukhbah Sany[1,*], & Fitri Indah Puspitaningsih[2]
[1]Design Furniture Study Program, Politeknik Industri Furnitur dan Pengolahan Kayu, Indonesia
[2]Furniture Industry Business Management Study Program, Politeknik Industri Furnitur dan Pengolahan Kayu, Indonesia

*Corresponding email: nukhbah.sanyi@poltek-furrnitur.ac.id

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Abstract: This study examines how furniture design students articulate professional learning and industrial awareness after completing an industrial internship. A qualitative research design was employed using a directed deductive-inductive thematic analysis. Data consisted of 33 written responses to an open-ended reflective questionnaire completed by Furniture Design Study Program students after their internship in the furniture industry. The questionnaire provided initial domains of attention related to industrial processes, design-production relationships, quality and efficiency, professional responsibility, communication and coordination, workplace experience, and business and career awareness, while coding within these domains was refined through close comparison of students' responses. The analysis identified seven interconnected themes: industrial system awareness, production-oriented design competence, quality and efficiency consciousness, communication and coordination competence, professional work attitude and accountability, human and organizational learning, and business and career awareness. Across these themes, students connected furniture design with participation in an interconnected industrial work system rather than only with visual and product-making activities. The findings indicate that structured post-internship reflection can make visible how students interpret production realities, workplace coordination, professional responsibility, and wider industrial relationships. The study concludes that industrial awareness provides an important organizing context for reflected professional learning in vocational furniture design.

Keywords: furniture design; industrial awareness; internship; professional competence; professional learning.

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INTRODUCTION

Vocational education is expected to prepare students not only with occupation-specific knowledge and technical skills, but also with the broader competencies required to participate effectively in professional work. These include work organization, cooperation, problem-solving, professional attitude, adaptability, communication, and the ability to respond appropriately to workplace expectations (Löfgren et al., 2023; Suroto et al., 2024). Work-readiness is therefore shaped by more than completing formal study requirements. Internship experience, motivation, digital literacy, and other individual and contextual factors have also been associated with students' preparation for work in vocational and diploma education (Naufalin et al., 2024; Supriyanto et al., 2022; Sutiman et al., 2022). These findings position workplace exposure as an important part of vocational preparation because it allows students to encounter professional requirements that cannot be reproduced fully through classroom learning alone.

Internship and work-integrated learning provide opportunities for students to engage with

authentic tasks, organizational routines, supervision, feedback, quality expectations, time constraints, and interaction with different workplace actors. Such experiences can contribute to professional readiness and workplace understanding by connecting formal learning with actual work practices (Aprile & Knight, 2020; Popov, 2024; Zehr & Korte, 2020). Internship learning, however, is not produced simply by being physically present in a workplace. The nature of tasks, feedback, novelty, autonomy, and interaction with supervisors or colleagues can shape what students perceive they learn during placement (Brodsky et al., 2024). Work-integrated learning assessment and structured reflective activities can further help students recognize and articulate what they have encountered in practice, particularly when workplace learning is informal or difficult to make visible (Boud et al., 2023; Luk & Chan, 2022; Øgård et al., 2025). Reflection is therefore treated in the present study not as evidence that professional competence has automatically developed, but as a means through which students express how they interpret their industrial experiences.

This relationship between academic learning and workplace realities is particularly important in furniture design education. Furniture design requires integrating creative intent with material knowledge, construction, technical documentation, ergonomics, manufacturing capability, quality requirements, cost, and collaboration with other professional functions. Studies of design education have shown that academic–industry collaboration can expose students to professional constraints, real-world project requirements, feedback, teamwork, and forms of decision-making that extend beyond conventional studio learning (Mavri et al., 2024; Razali et al., 2024). In furniture design specifically, Junaidy et al. (2026) showed that academic–industrial collaboration can involve prototype development, manufacturability, production constraints, market considerations, and professional collaboration. These perspectives suggest that professional preparation in furniture design involves understanding not only how a product is conceived, but also how design decisions operate within production and organizational systems.

In this study, professional learning refers to how students interpret internship experience in relation to the competence, behavior, responsibility, relationships, and expectations associated with professional practice. Internship research indicates that workplace learning may encompass technical knowledge, non-technical competencies, organizational understanding, interpersonal learning, professional values, and emerging professional identity (Dempsey et al., 2024; Luk & Chan, 2022; Zehr & Korte, 2020). Alongside professional learning, the study uses industrial awareness as an interpretive concept for students' recognition that furniture design is embedded within an interconnected industrial system involving material selection, technical documentation, production planning, manufacturing, quality control, communication, organizational relationships, delivery, and commercial considerations. Industrial awareness is not treated as a standardized competency or directly measured attribute. Rather, it provides an analytical lens for examining how students connect design activity with the wider conditions of industrial work. This framing is consistent with research emphasizing boundary crossing between educational and workplace practices and the need for design students to engage with real industrial contexts (Junaidy et al., 2026; Mavri et al., 2024; Popov, 2024; Razali et al., 2024).

Existing research has examined vocational competencies, work-readiness, internship learning outcomes, workplace socialization, work-integrated learning assessment, and industry collaboration in design education (Aprile &

Knight, 2020; Löfgren et al., 2023; Luk & Chan, 2022; Popov, 2024; Zehr & Korte, 2020). Design-education research has also increasingly considered how engagement with industry supports students' encounters with professional constraints and real-world practice (Junaidy et al., 2026; Mavri et al., 2024; Razali et al., 2024). However, within this literature, comparatively limited attention has been given to how furniture design students themselves articulate the interconnected technical, organizational, relational, and professional meanings of internship experience. To address this gap, the present study explores professional learning and industrial awareness through students' post-internship reflective accounts. Because the reflective questionnaire was intentionally structured around several aspects of industrial experience, the analysis does not treat the resulting thematic domains as wholly emergent from an unstructured dataset. Instead, a directed deductive-inductive thematic analysis uses the questionnaire domains as initial areas of analytical attention while allowing specific codes, thematic distinctions, and relationships to be refined through comparison of students' responses. The study is guided by three questions: (1) How do furniture design students articulate professional learning after an internship? (2) What forms of industrial awareness are reflected in their accounts? Moreover, (3) How are the identified dimensions of professional learning and industrial awareness interrelated within students' post-internship reflections? The study contributes a data-based interpretation of how students connect furniture design with production, quality, coordination, organizational relationships, professional accountability, and wider business and career contexts.

■ METHOD

Research Design

This study employed a qualitative research design to examine how furniture design students articulated professional learning and industrial awareness after completing an industrial internship. The study focused on students' reflective accounts rather than on measuring the statistical effects of the internship. The responses were analyzed using a deductive-inductive codebook thematic analysis. This analytical orientation was selected because the reflective questionnaire was structured around predefined areas of industrial experience, including industry processes, design-production relationships, quality and efficiency, professional responsibility, communication and coordination, workplace experience, and business and career awareness. These areas provided an initial deductive framework for organizing the data. At the same time, the specific codes, category distinctions, theme boundaries, and relationships among themes were refined through close engagement with students' responses.

Thematic analysis encompasses different analytical approaches, including codebook-based forms in which an initial coding framework can guide systematic analysis while remaining open to modification as interpretation develops (Braun & Clarke, 2021). A combined deductive-inductive approach integrates predefined areas of analytical interest with codes and patterns identified from the data themselves (Fereday et al., 2006). In the present study, this approach was used to examine both the areas intentionally prompted by the questionnaire and the particular ways students described, connected, and interpreted their internship experiences.

Participants and Research Context

This study was conducted in a Furniture Design Study Program within a Professional Ethics course. The participants were furniture design students who had completed an industrial internship and subsequently reflected on their experiences in relation to professional work. The analyzed dataset comprised 33 written reflective responses eligible for research use under the

consent procedure described in the Trustworthiness and Ethical Considerations subsection. The unit of analysis was the students' written reflections, not their course grades, academic achievement, or direct workplace performance. The reflections addressed students' experiences with furniture design practice, production processes, material and construction considerations, quality standards, communication and coordination, workplace discipline, organizational culture, professional responsibility, and early career awareness.

Data Collection

Data were collected through an open-ended reflective questionnaire administered as a course-based assignment. The instrument included 33 open-ended questions and a separate consent item on using responses as research data. The questions invited students to describe concrete experiences of industrial work and reflect on industry processes, design-production relationships, material and production considerations, quality and efficiency, professional responsibility, communication and coordination, workplace experience, and business and career awareness. These areas were intentionally incorporated into the questionnaire as predefined domains of reflection so that students considered multiple dimensions of their internship experience. They therefore served as initial areas of analytical attention rather than categories assumed to emerge independently from an unstructured dataset. Students were encouraged to explain situations, reasons, consequences, and professional learning in their own words rather than respond to fixed response categories, predetermined judgments, or evaluative statements. They were also instructed not to identify companies, clients, supervisors, employees, or other individuals in their responses.

Qualitative questionnaires can generate rich, meaningful written accounts when their questions prioritize qualitative values and invite participants to elaborate on their experiences (Tombs & Strange, 2024). Open-ended questions also allow respondents to answer in their own words and to explain, qualify, and clarify their responses, although the amount of detail provided may vary considerably among participants (Gillespie et al., 2021). Because the questionnaire directed attention toward particular aspects of industrial experience, the analysis did not treat the presence of those broad areas across participants as evidence of spontaneous thematic prominence. Instead, the analysis focused on how students described those areas, the specific meanings and distinctions within them, and the relationships they articulated across different aspects of professional and industrial experience. To reduce the possibility that responses reflected only perceived course expectations, the questionnaire emphasized experience-based descriptions rather than agreement with predetermined statements. However, the written responses were not independently verified through follow-up interviews or workplace documents. They were therefore treated as students' reflective accounts of their experiences rather than as independently verified records of workplace events.

Data Analysis

The 33 written reflections were analyzed using a deductive-inductive codebook thematic analysis. The responses and coding records were organized in a structured spreadsheet to maintain traceability among respondent codes, questionnaire items, textual segments, codes, categories, and themes. The predefined domains represented in the questionnaire provided the initial deductive structure for analysis, but they were not treated as final themes. Thematic analysis provides a flexible procedure for identifying and interpreting patterned meanings while requiring explicit attention to familiarization, coding, theme development, review, and definition (Kiger &

Varpio, 2020). In the present study, analysis proceeded through five iterative stages.

First, all responses were read closely to become familiar with the dataset and to identify meaningful segments relevant to professional learning and industrial awareness. Second, these segments were assigned initial codes. Some codes reflected the areas intentionally addressed by the questionnaire, including industrial processes, design-production relationships, quality and efficiency, professional responsibility, communication and coordination, workplace experience, and business and career awareness. At the same time, codes were added or refined inductively when students expressed meanings, distinctions, or relationships that were not adequately represented by the initial coding framework. This combination of theoretically or instrument-informed starting points with data-responsive coding is consistent with hybrid deductive-inductive thematic analysis (Fereday et al., 2006; Saunders et al., 2023). A textual segment could receive more than one code when it contained more than one analytically relevant meaning. Third, the coding framework was developed into a structured codebook containing the code label, definition, inclusion criteria, exclusion or boundary criteria, and representative textual examples. Developing and revising a codebook can strengthen analytical consistency while also supporting reflection on how codes are defined, differentiated, and applied, including when qualitative analysis is undertaken by an individual researcher (Oliveira, 2023). The codebook was therefore treated as an evolving analytical record rather than a fixed classification established before engagement with the data. It was revised iteratively when codes overlapped, required greater specificity, or represented meanings that were better combined or separated. This documentation of changing code definitions and analytical decisions also supported transparency in the movement from initial coding to the final analytical structure (Reyes et al., 2024).

Fourth, related codes were compared across responses and grouped into broader analytical categories and candidate themes. Candidate themes were then reviewed against both the coded extracts and the complete dataset to examine their internal coherence, distinctions from other themes, and relevance to the research questions. Fifth, the themes were defined and named, and relationships among them were interpreted by examining how students connected technical, operational, relational, organizational, professional, and commercial aspects of industrial experience. The process therefore moved iteratively between coded segments, categories, candidate themes, and the wider dataset rather than treating theme development as a direct conversion of questionnaire topics into findings.

Analytical consistency was supported through repeated checking of coded segments against the original responses, comparison of code applications across participants, documentation of coding decisions, and revision of code definitions and theme boundaries when inconsistencies or ambiguities were identified. These procedures created an audit trail of the analytical process rather than a statistical test of intercoder reliability. Code and theme frequencies were also not treated as direct measures of qualitative importance, since frequency alone does not establish the analytical significance of a pattern (Saunders et al., 2023). After the themes had been finalized, respondent coverage was calculated as the number of participants whose responses contained at least one coded segment associated with each theme. Because the questionnaire explicitly prompted reflection across the broad analytical domains, respondent coverage was used only to describe the distribution of coded material and not as evidence

of spontaneous thematic prominence or relative importance.

To examine the interrelationships addressed in the third research question, a separate AI-assisted thematic co-occurrence procedure was conducted after the seven-theme structure and codebook had been finalized. For this analysis, each participant's answer to one open-ended questionnaire item was treated as one response unit, producing 1,089 units across 33 participants and 33 questions. The AI-assisted procedure did not generate the research questions, initial thematic framework, or final theme definitions. Instead, it applied the established seven-theme codebook across the complete set of response units so that more than one thematic label could be assigned when a response contained meanings associated with multiple dimensions.

The automated classification combined seven one-versus-rest term frequency–inverse document frequency (TF–IDF) logistic-regression classifiers, trained on questionnaire responses anchored to the relevant thematic domains, with codebook-prototype text similarity to detect additional thematic content within the same response unit. Theme-specific probability thresholds for the primary classifications were selected using five-fold cross-validation to maximize F1 performance on the anchor labels. For secondary-theme detection, a theme was retained when its prototype similarity reached 0.025 and was at least 50% of the strongest prototype similarity within that response unit, with a maximum of four thematic labels permitted per unit. The coding output, probability values, similarity scores, and classification decisions were retained in a structured audit file. A sensitivity analysis varying the secondary similarity threshold from 0.020 to 0.030 indicated that the rank ordering of thematic pairs remained highly stable across the tested thresholds.

A thematic co-occurrence was recorded when two final themes were assigned to the same response unit. Pairwise counts were then tabulated in a symmetrical matrix to identify recurring thematic relationships. This procedure follows the broader rationale of thematic co-occurrence analysis, which examines relationships among themes rather than treating each thematic dimension as analytically isolated (Scharp, 2021). The co-occurrence counts were interpreted descriptively and were not treated as correlations, inferential statistical associations, or evidence that one thematic dimension caused another. The automated output was used as an analytical aid to extend the qualitative interpretation of the finalized themes rather than as an independent replacement for thematic interpretation.

All participant quotations presented in the Results and Discussion were originally written in Indonesian and translated into English by the authors for publication while preserving their intended meaning.

Trustworthiness and Ethical Considerations

Trustworthiness was supported through repeated reading of the responses, comparison across participants, analytic memoing, and continued checking of developing codes, categories, and themes against the original data. Following the revised codebook-based analytical procedure, code definitions, inclusion and boundary criteria, coding decisions, and changes to category or theme structure were documented throughout the analysis. The structured codebook and analytic memos therefore functioned as an audit trail linking textual segments to codes, categories, and final themes. Because qualitative coding necessarily involves researcher interpretation, analytic memos also recorded the reasoning behind coding decisions and identified points at which interpretations required

reconsideration or refinement. Repeated reading and cross-response comparison were used to examine whether interpretations remained consistent with students' written accounts and to identify both recurring patterns and differences among responses. Developing and maintaining transparent documentation of coding decisions can strengthen the dependability and traceability of qualitative analysis, particularly when a codebook is revised iteratively during analysis (Oliveira, 2023; Reyes et al., 2024). These procedures were intended to support analytic transparency, consistency, and traceability between the original responses and the interpretations developed from them. Transparency in analytical procedures, clear documentation of methodological decisions, and continued attention to the relationship between data and interpretation are important elements of qualitative trustworthiness (Ahmed, 2024; Stenfors et al., 2020).

Ethical considerations were particularly important because the questionnaire was administered as a course-based reflective assignment and the participants were students taught within the program. Before completing the reflective questions, students were informed that their responses could be used for academic research only in anonymized form and were asked to provide separate consent for research use. They were explicitly informed that agreeing or declining would not affect their course grade, and only responses accompanied by consent were eligible for inclusion in the research analysis. The questionnaire also instructed students not to identify companies, clients, supervisors, employees, or other individuals. Research data were anonymized using respondent codes, and research use of the responses was separated from academic assessment, with analysis conducted after the relevant assessment process had been completed.

These safeguards were intended to reduce the possibility that the teacher–student relationship would influence students' decisions about research participation and to protect participants' confidentiality. Such considerations are especially important when instructors conduct research involving their own students because differences in institutional authority may create perceived pressure to participate even when participation is formally voluntary (Noy et al., 2025; Stenfors et al., 2020). The separation of research consent from course assessment, the explicit statement that consent would not affect grades, anonymization of the data, and delayed research analysis were therefore used to maintain voluntary participation and confidentiality within the course-based research context.

■ RESULT AND DISCUSSION

The deductive-inductive codebook thematic analysis resulted in seven final themes: industrial system awareness, production-oriented design competence, quality and efficiency consciousness, communication and coordination competence, professional work attitude and accountability, human and organizational learning, and business and career awareness. Coded material associated with each theme was present in the responses of all 33 participants. This coverage should be interpreted in relation to the questionnaire design, which intentionally directed students to reflect across the broad areas from which these themes were developed. Accordingly, the 33/33 coverage indicates that all participants provided analyzable material within each broad thematic area; it does not indicate that the themes arose spontaneously with equal prominence, frequency, or importance. Table 1 summarizes the relationship between the initial questionnaire domains, refined codes and categories, final themes, respondent coverage, theme definitions, and representative quotations students' responses.

Table 1. Integrated deductive-inductive coding matrix of professional learning and industrial awareness after internship

Initial Questionnaire Domain(s)	Refined Codes/Categories	Final Theme	Theme Definition	Respondent Coverage (n/33)	Representative Quotation
Industry processes; design-production relationships	Industrial workflow; interconnected divisions; production stages; quality control; product delivery; information flow	Industrial system awareness	Recognition that furniture design operates within an interconnected system of functions, decisions, and information flows rather than as an isolated design activity.	33/33	"Each division has different roles, targets, and responsibilities, but they must work in alignment for the production process to run smoothly. Delays, data errors, or poor communication in one division can affect subsequent processes and the overall workflow." (R27)
Design-production relationships; material and production considerations	Material; construction; working drawings; machine capability; production feasibility; design revision	Production-oriented design competence	Interpretation of design decisions in relation to material, technical, human, and operational conditions that determine whether a design can be produced.	33/33	"The available machines could not support several of the required processes. The complexity of the design also required skills that were not yet fully available among the workers. The design was therefore adjusted and simplified…" (R22)
Quality and efficiency; material and production considerations	Quality standards; drawing accuracy; revision control; time; cost; material use; rework; waste; delays	Quality and efficiency consciousness	Recognition that technical and communication decisions can affect product quality, resource use, production time, rework, and operational continuity.	33/33	"Small errors, such as unclear working drawings, poorly documented revisions, or miscommunication between units, can lead to rework, material waste, and production delays." (R15)
Communication and coordination; industry processes	Information transfer; cross-functional coordination; teamwork; design-PPIC-production-quality interaction; feedback	Communication and coordination competence	Understanding communication as the accurate movement and coordination of technically relevant information across work units.	33/33	"When the production team encounters difficulty producing a particular detail, that information must quickly reach the design team so that a solution or modification can be proposed." (R28)
Professional responsibility; workplace experience	Discipline; responsibility; accuracy; deadlines; professional standards; revision; adaptability; consequences of errors	Professional work attitude and accountability	Recognition that professional reliability involves completing work accurately and responsibly while understanding its consequences for coworkers, production, and product outcomes.	33/33	"In a professional environment … one's work can affect other people's work, the continuity of production, and even the quality of the product received by the customer." (R04)
Workplace experience; communication and coordination	Workplace culture; interpersonal differences; communication styles; criticism; pressure; emotional regulation; adaptation	Human and organizational learning	Awareness that professional participation requires adapting to workplace norms, authority relationships, interpersonal differences, feedback, and organizational expectations.	33/33	"I encountered supervisors, coworkers, and production teams with different communication styles, expectations, and approaches. … I learned to adjust how I communicate, manage my emotions when receiving criticism or working under pressure…" (R02)
Business and career awareness	Market; cost; suppliers; business opportunities; consumers; entrepreneurship; career possibilities; supply chain	Business and career awareness	Recognition of the commercial considerations and occupational opportunities surrounding furniture design and production.	33/33	"Running a furniture business is not only about artistic idealism, but also about managing risk, maintaining communication across teams, and making financially reasonable decisions…" (R05); "I realized that many other fields also offer significant opportunities." (R02)

Across the seven themes, students described internship learning as extending beyond completing design tasks. Their reflections connected furniture design with production processes, material and construction decisions, quality standards, communication across work units, professional responsibility, organizational relationships, and business considerations. Because these broad areas were intentionally represented in the questionnaire, their presence across participants is not interpreted as evidence that they arose spontaneously from the data. The analytical contribution lies instead in how students described the specific meanings, consequences, and connections within and across these areas. Rather than providing evidence of a measured before-and-after change, the responses show how students interpreted professional work after experiencing the industrial environment. In many responses, students contrasted their previous emphasis on visual or academic design outputs with the broader requirements they encountered in industry, particularly production feasibility, coordination, accuracy, time, cost, and responsibility.

Taken together, the refined themes indicate an overarching interpretive pattern in which furniture design was understood less as an isolated act of visual or product creation and more as participation in an interconnected industrial work system. This interpretation is consistent with work-integrated learning research showing that internship learning can involve multiple dimensions of professional readiness rather than technical knowledge alone (Aprile & Knight, 2020; Luk & Chan, 2022). In the present study, however, the furniture design context makes the interdependence between design, production, quality, communication, and organizational work particularly visible. The following thematic sections examine these dimensions individually before considering their interrelationships through thematic co-occurrence analysis.

Theme 1: Industrial System Awareness

Industrial system awareness was retained as a final theme because, in responses to questionnaire domains on industry processes and design-production relationships, students repeatedly described furniture production in terms

of interconnected stages, work units, decisions, and information flows. Their reflections referred to relationships among design, material procurement, PPIC, production, quality control, finishing, packing, delivery, and other organizational functions. Rather than describing a furniture product as the outcome of design activity alone, students frequently situated design within a sequence of decisions and responsibilities involving several parts of the company. Coded material associated with this theme was present in all 33 participants, although this coverage reflects the structured scope of the questionnaire and should not be interpreted as spontaneous thematic prominence. The analytically relevant pattern was the way students described dependencies and consequences across different parts of the production system. R27, for example, explained the interdependence of different organizational units:

> "*Each division has different roles, targets, and responsibilities, but they must work in alignment for the production process to run smoothly. Delays, data errors, or poor communication in one division can affect subsequent processes and the overall workflow*." (R27)

The quotation illustrates that industrial awareness involved more than recognizing the existence of different departments. It also included understanding that decisions, information, and delays in one part of the organization could affect subsequent stages of work. R27 also described furniture production as involving design, purchasing, production, quality control, and other functions that depend on one another to maintain the overall workflow. The distinction is important because the questionnaire could prompt students to discuss different industrial functions. However, it did not predetermine whether students would describe those functions as mutually dependent or identify downstream consequences when coordination failed. This relational interpretation was developed from the content of their responses.

This finding supports the role of industrial internships in exposing vocational students to work processes that are difficult to fully reproduce in classroom settings. Sutiman et al. (2022) emphasized work-based learning as a means of strengthening the connection between vocational education and industry requirements, while Junaidy et al. (2026) showed that academic-industrial collaboration in furniture design brings students into contact with prototype development, production constraints, and professional interaction. A complementary perspective is offered by Popov (2024), who describes internship learning through boundary crossing and horizontal expertise, emphasizing the capacity to understand and operate across different practices and organizational contexts. Research on collaboration between designers and manufacturing or craft practitioners similarly shows that design work is shaped through interaction between participants who contribute different forms of production knowledge and expertise (Gerea et al., 2023). The present findings add a more explicit system-level dimension to this discussion. Students not only reported learning individual technical tasks; they described how those tasks were connected through organizational processes and how design information could influence the work of other units.

This distinction is important for furniture design education. Understanding industrial systems means recognizing that a design decision enters a wider chain of production, information, quality, and coordination. The findings therefore position industrial system awareness not simply as knowledge of a company's departmental structure, but as an understanding of functional

interdependence: how information, decisions, constraints, and errors can move across work units and affect subsequent activities. In this sense, industrial awareness provides a context for the other themes identified in the study: production-oriented competence concerns whether design can be realized within that system, quality and efficiency concern the consequences of decisions within it, and communication and coordination concern how information moves across it. Its relationships with these other dimensions are examined more directly in the thematic co-occurrence analysis rather than inferred solely from the themes' presence across participants.

Theme 2: Production-Oriented Design Competence

Production-oriented design competence was retained as a final theme because students did more than identify materials or production processes when responding to questionnaire domains concerning design-production relationships and material and production considerations. Their accounts repeatedly connected design decisions with material characteristics, construction, working drawings, machine capability, workforce capability, and production feasibility. Rather than discussing design primarily in terms of form or visual quality, students frequently described the need to consider whether a design could be produced within the workplace's technical and operational conditions. Coded material associated with this theme was present in all 33 participants, although the breadth of coverage is partly attributable to the questionnaire structure. The analytically refined pattern concerned how students evaluated design intentions against actual production conditions and described modification as part of design judgment.

R22 provided a particularly clear example of how production conditions influenced a design decision:

> *"After discussion with the sample and production teams, it became clear that the available machines could not support several of the required processes. The complexity of the design also required skills that were not yet fully available among the workers. The design was therefore adjusted and simplified so that it could still be produced effectively."* (R22)

This account shows that production-oriented competence involved more than knowing how furniture is manufactured. The student described evaluating a design against available machinery, workforce capability, production difficulty, time, and cost before modifying it for implementation. The original response further emphasized that a design may be visually attractive but still require adjustment when production technology and human capability cannot support the intended form. The questionnaire invited reflection on design and production, but it did not prescribe this particular relationship between machine capability, workforce capability, and design revision. That relationship emerged from the student's account.

Similar considerations appeared elsewhere in the dataset through references to working-drawing accuracy, material availability, construction systems, hardware, machine limitations, and repeated design revision. These reflections suggest that students understood production feasibility as part of design judgment rather than as a separate concern that begins only after design is completed. Design feasibility was therefore interpreted as a negotiated fit among design intent, material characteristics, technical information, available processes, and the capabilities of the production setting. The industrial setting made visible the practical consequences of decisions that may appear relatively abstract during classroom-based design work.

This finding is consistent with Junaidy et al. (2026), who described furniture design learning in academic-industrial collaboration as involving prototype development, production constraints, and professional interaction. Recent industrial design education research also emphasizes the importance of connecting design preparation with manufacturing knowledge and technological capability. Rapitsenyane et al. (2023) fFor example, research examined integrating digital manufacturing skills into industrial design education and highlighted the relevance of manufacturing technologies and industry-oriented skills to design preparation. Research on design for manufacturing likewise shows that effective design requires awareness of process- and machine-specific constraints rather than treating manufacturing as a concern that follows creative development (Thomas-Seale et al., 2023). The present study adds a more specific interpretation: students' reflections show that production-oriented design competence involves negotiating design intent with actual production capability. That negotiation may require adjusting dimensions, simplifying details, changing materials, reconsidering construction, or responding to limitations in machinery and workforce skills.

From a vocational education perspective, this theme also supports the view that work-based learning strengthens the relationship between educational preparation and actual industry requirements. Sutiman et al. (2022) emphasized the role of industrial internship in connecting vocational education with workplace needs. In the present study, that connection became visible through students' explanations of why a technically or visually acceptable design could still require modification before production. Production-oriented design competence is therefore interpreted here not as demonstrated manufacturing competence, but as reflected recognition that design decisions must be technically communicable, materially feasible, and operationally realizable within a particular production context. Its relationships with quality, communication, and other thematic dimensions are examined separately through the thematic co-occurrence analysis.

Theme 3: Quality and Efficiency Consciousness

Quality and efficiency consciousness was retained as a final theme because students did more than identify quality standards or production efficiency when responding to the relevant questionnaire domains. Their accounts repeatedly connected technical decisions, information accuracy, revision control, material use, and communication with consequences for rework, waste, production time, cost, and continuity of work. Across the responses, students referred to drawing accuracy, material use, revision control, production time, rework, quality checking, and cost. Material-related coding was present in all 33 participants, although this broad coverage should be interpreted in relation to the questionnaire structure. The analytically refined pattern concerned how students described action–consequence relationships within the production process. R15 illustrated this relationship particularly clearly:

> *"Small errors, such as unclear working drawings, poorly documented revisions, or miscommunication between units, can lead to rework, material waste, and production delays."* (R15)

This account shows that quality and efficiency were not understood only as final product outcomes. Instead, the student connected them to earlier decisions concerning drawings, information accuracy, documentation, and communication between work units. In the original response, R15 also linked these errors to additional production time, material use, and cost,

showing an awareness that mistakes at one stage can create consequences elsewhere in the production process. Although the questionnaire explicitly invited reflection on quality and efficiency, it did not prescribe this particular chain linking information quality and communication failures with rework, waste, and delay. This relationship emerged from the content of the students' responses.

Similar reflections appeared in students' descriptions of material selection, dimensional accuracy, construction, finishing, quality control, and the need to reduce unnecessary revision or rework. These responses suggest that students understood efficiency as more than working quickly. It also involved reducing avoidable errors, using material appropriately, maintaining clear information, and ensuring that work could proceed without unnecessary interruption. Quality was likewise described as something influenced by decisions made throughout the process rather than something inspected only after production was completed. This interpretation aligns with manufacturing research showing that rework and internally generated production variation can arise from quality problems, faulty design, unclear specifications, inadequate information, and other controllable organizational causes, with consequences for capacity, material flow, cost, and delivery performance (Hedvall & Mattsson, 2024).

This interpretation extends the production-oriented competence described in Theme 2. Whereas production-oriented design competence concerns whether a design can be realized under actual manufacturing conditions, quality and efficiency consciousness concerns the consequences of how accurately and effectively that realization occurs. In this sense, design decisions, technical information, material use, production time, and quality control were understood by students as interconnected rather than separate concerns. The distinction also helps avoid reducing "quality" to final inspection: within students' accounts, quality consequences could originate earlier through drawings, revisions, communication, material decisions, and production execution.

From a workplace-learning perspective, this theme is closely related to learning from errors and their consequences. Zhao et al. (2018), in studies involving apprentices in dual vocational training, showed that learning from errors is an important aspect of early workplace development and that trainees' responses to mistakes are influenced by the way errors are handled within the training environment. More recent workplace research defines error learning as involving reflection on errors, examination of their causes, recognition of action–outcome relationships, and use of that understanding to improve subsequent decisions or behavior (van Mourik et al., 2023). Their findings also emphasize that workplace conditions can either support or inhibit learning from mistakes. In the present study, these ideas were reflected more specifically in students' recognition that errors in drawings, revisions, materials, or communication could affect production schedules, resource use, product quality, and the work of others. Quality and efficiency consciousness is therefore interpreted as reflected awareness of industrial consequences rather than as demonstrated quality-management competence. Its relationships with production-oriented design competence, communication, and accountability are examined more directly through the thematic co-occurrence analysis.

Theme 4: Communication and Coordination Competence

Communication and coordination competence was retained as a final theme because students did more than identify communication as a general workplace skill when responding to questionnaire domains concerning coordination and industrial processes. Their accounts

repeatedly described how technically relevant information, production problems, material requirements, revisions, and schedules moved across roles and work units. Students referred to interactions involving design, PPIC, production, quality control, supervisors, and other work functions. Evidence related to this theme appeared across all 33 participants, although its widespread presence should be understood in light of the questionnaire's structured coverage. A more distinctive analytical pattern was how students portrayed communication as a mechanism for moving information, coordinating decisions, and responding to issues across functional boundaries. R28 described this cross-functional relationship particularly clearly:

> *"During the internship, I realized that coordination between units is a key factor in the furniture industry. Each division, from design and PPIC to production and quality control, must share information accurately. For example, when the production team encounters difficulty producing a particular detail, that information must quickly reach the design team so that a solution or modification can be proposed."* (R28)

This account illustrates communication as the movement of technically relevant information between units with different responsibilities. The student did not describe coordination only as working well with others; the example involved a production problem being communicated back to design so that an appropriate modification could be considered. R28 further connected coordination with material requirements, machine scheduling, delivery details, production efficiency, and error reduction. Although the questionnaire invited students to discuss communication and coordination, it did not predetermine this particular feedback relationship in which production difficulty triggers information transfer, design reconsideration, and cross-functional decision-making.

Similar patterns appeared elsewhere in the dataset through references to working drawings, verbal explanations, revision information, consultation with production staff, and cross-department confirmation. These reflections suggest that communication competence in furniture production includes the ability to convey information clearly, confirm shared understanding, respond to feedback, and translate design intentions into information that other functions can use. Coordination extends this process by ensuring that decisions made in one part of the organization remain aligned with the requirements and activities of other parts. This interpretation is consistent with research on designer-craftsperson and designer-manufacturer collaboration, where effective collaboration depends on combining different forms of knowledge and enabling communication between participants who contribute distinct practical and design expertise (Gerea et al., 2023).

This interpretation is consistent with vocational education research that identifies cooperation ability, active listening, and other interpersonal competencies as important domain-general competencies for vocational students. Löfgren et al. (2023), for example, identified cooperation ability as encompassing teamwork and interpersonal skills and showed that such competencies form an important part of vocational learning alongside work organization and professional attitude. The present findings extend this general view by showing that communication in furniture production is also shaped by functional differences among design, planning, production, quality, and supervisory roles. Students' accounts suggest that effective coordination requires not only interpersonal skill, but also an understanding of who holds relevant

information, who can act on it, and how information must move between roles before a technical problem can be resolved.

A useful additional perspective is provided by Popov (2024), who conceptualizes internship learning partly through boundary crossing and the development of "horizontal expertise", the capacity to operate across different contexts, negotiate meanings, and coordinate activities involving different practices. This perspective is particularly relevant to the present findings because students described situations in which they had to connect design requirements with the concerns of PPIC, production, quality control, and other units. Such encounters also place interns in interactions with people whose workplace experience, authority, and technical expertise may differ from their own. In the present dataset, however, seniority or status differences were not consistently coded as a distinct barrier to communication. The evidence therefore supports an interpretation centered on functional boundary crossing and role-differentiated interaction rather than a stronger claim that communication problems were primarily caused by hierarchy or by relationships between interns and senior craftspeople or technicians.

Communication and coordination competence can therefore be interpreted as a cross-functional capability that enables design information and workplace decisions to move across the industrial system, rather than merely as a general interpersonal soft skill. Its empirical relationships with production-oriented design competence, quality and efficiency consciousness, and other themes are examined subsequently through the thematic co-occurrence analysis.

Theme 5: Professional Work Attitude and Accountability

Professional work attitude and accountability were retained as a final theme because students did more than identify discipline or responsibility as desirable workplace qualities. Their responses repeatedly linked accuracy, timeliness, adaptability, responsiveness to correction, and completion of assigned work with consequences for coworkers, production processes, and product outcomes. Students frequently contrasted the expectations attached to academic assignments with those they encountered in professional settings, particularly the requirement that work be completed accurately and on time because its consequences extend beyond the individual completing the task. Although professional responsibility was an explicit questionnaire domain, the more distinctive analytical pattern concerned how students interpreted responsibility through dependability and the consequences of individual actions within an interdependent work system. R04 articulated this distinction clearly:

> *"What most distinguishes the professional environment from university is the level of responsibility and the consequences of each task. At university, mistakes generally affect only one's grade or personal learning process. In a professional environment, however, one's work can affect other people's work, the continuity of production, and even the quality of the product received by the customer."* (R04)

This account places accountability within a chain of consequences rather than treating responsibility as an abstract personal value. R04 associated professional work with effects on coworkers, production continuity, and product quality, indicating an understanding that individual performance is embedded within a larger work system. The questionnaire invited reflection on professional responsibility, but it did not predetermine this contrast between academic and

workplace consequences or the student's interpretation of accountability as responsibility for effects extending beyond the individual task.

Similar patterns appeared in students' references to meeting deadlines, following workplace rules, checking work carefully, responding to revisions, accepting feedback, and completing tasks in ways that other units could rely on. These responses suggest that professional attitude was understood not simply as being disciplined or well-behaved, but as demonstrating reliability when errors, delays, or incomplete work can affect subsequent activities. Adaptability was also relevant because instructions, customer requirements, design specifications, and production conditions could change during the work process. Professional accountability was therefore interpreted through both task performance and relational consequence: being dependable involved not only completing one's own work, but also recognizing that other people and processes may depend on its accuracy, timing, and completeness.

This theme therefore extends the previous findings on production, quality, and coordination. Production-oriented competence concerns whether design decisions are feasible, quality and efficiency consciousness concerns their operational consequences, and communication and coordination competence concerns how information moves between work units. Professional accountability adds a behavioral dimension to these competencies by emphasizing whether individuals can be relied upon to carry out their responsibilities accurately, respond appropriately to changing requirements, and recognize the effects of their work on others. These conceptual connections are treated here as an interpretation of the theme; their empirical co-occurrence with other thematic dimensions is examined separately in the subsequent co-occurrence analysis.

This interpretation is consistent with recent work-integrated learning research showing that workplace placements expose students to professional requirements that extend beyond technical or academic performance. Dempsey et al. (2024), in a longitudinal study of students before, during, and after placement, showed that placement experiences involved negotiation of professional values, competencies, and expectations as students considered their fit with professional practice. More recently, Wang and Hu (2025) found among engineering students that work-integrated learning was associated with a more pragmatic and collaborative professional mindset, practical and interpersonal competencies, and stronger engagement with professional values. In vocational education, Supriyanto et al. (2022) likewise reported a positive relationship between internship experience and work readiness among vocational students.

In the present study, these broader ideas were expressed particularly through students' recognition of consequence and dependability: professional work was understood as work for which other people, production processes, and product outcomes may depend on the individual performing a task appropriately. Professional work attitude and accountability is therefore interpreted as reflected awareness of reliability, responsibility, and consequence within industrial work rather than as evidence that professional maturity or accountable behavior was directly measured or fully achieved.

Theme 6: Human and Organizational Learning

Human and organizational learning was retained as a final theme because students' reflections extended beyond learning workplace procedures to interpreting the social and organizational conditions under which

professional work occurs. Students described adapting to different personalities, communication styles, work expectations, organizational routines, and workplace pressures. Responses from all participants contained material relevant to this theme. However, its analytical significance lies less in this coverage than in how students described adjustment to people, norms, authority, feedback, and situational expectations. Students referred not only to what they were expected to do, but also to how they needed to interact with supervisors, coworkers, and production personnel whose approaches, priorities, and communication styles could differ from their own. These reflections positioned professional learning as a social and organizational process in addition to a technical one. R02 described this aspect of workplace experience particularly clearly:

> *"One aspect of working life that I do not think can be learned through coursework alone is how to remain professional when dealing with people who have different personalities and ways of working. In the workplace, I encountered supervisors, coworkers, and production teams with different communication styles, expectations, and approaches. ... I learned to adjust how I communicate, manage my emotions when receiving criticism or working under pressure, and remain professional in different situations."* (R02)

The account illustrates that workplace adaptation involved more than acquiring communication techniques. R02 connected professional behavior with interpreting different expectations, regulating emotional responses, receiving criticism, and adjusting communication according to the people and situations encountered. The original response explicitly described learning to adapt communication and control emotions under criticism or pressure. Although workplace experience was intentionally included in the questionnaire, this more specific combination of interpersonal difference, feedback, emotional regulation, and situational adjustment emerged from the content of students' accounts rather than being predetermined by the instrument.

Similar reflections appeared in accounts of adjusting to different work rhythms, understanding supervisors' expectations, asking for clarification, receiving corrections, coping with deadlines, and learning how responsibilities were distributed within the organization. These responses suggest that students' understanding of professional competence extended beyond individual technical ability. Working effectively in an industrial environment also required recognizing workplace norms, interpreting other people's expectations, and adjusting one's behavior without losing responsibility for the task being performed. This pattern is consistent with organizational socialization research, which conceptualizes entry into a workplace as a process of learning role expectations, workplace norms, relationships, and accepted ways of participating. Recent research with interns similarly shows that socialization is supported through interactions with supervisors and peers, access to feedback, and opportunities to understand workplace culture and expectations (Chue et al., 2024).

This theme differs importantly from communication and coordination competence. Theme 4 concerns the functional movement of information across design, PPIC, production, quality control, and other units. Human and organizational learning concerns the social environment in which that coordination occurs: different personalities, authority relationships, communication styles, workplace expectations, and responses to pressure or correction. The distinction indicates that knowing what information must be communicated does not

automatically mean that an individual can navigate the interpersonal and organizational conditions under which communication takes place. The two themes may therefore intersect in particular responses. However, they represent different analytical emphases: Theme 4 concerns coordinating work across functions, whereas Theme 6 concerns adjusting to the people, norms, expectations, and relationships through which that work is performed. Their empirical overlap is examined subsequently through the thematic co-occurrence analysis.

This interpretation is strongly supported by Zehr and Korte (2020), whose qualitative study of engineering interns and internship supervisors examined internships as a social learning environment. Their findings showed that students learned not only how organizations functioned but also how to work with others in professional environments, emphasizing relationships and workplace socialization as important dimensions of internship learning. Löfgren et al. (2023) similarly identified cooperation, interpersonal skills, active listening, and professional attitude as domain-general competencies relevant to vocational learning environments. More recent organizational-socialization research further emphasizes that newcomers' learning and adjustment depend partly on socialization agents such as supervisors and coworkers, who provide information, feedback, guidance, and opportunities for sensemaking. A systematic qualitative review by Frögéli & Backström Eriksson (2025) also shows that the quality of such support is shaped by role clarity, available time, organizational support, and the expectations held by both newcomers and those supporting them.

These perspectives help situate R02's account within a broader understanding of workplace learning as relational and context-dependent. The student's need to interpret different expectations, receive criticism, adjust communication, and remain professional under pressure reflects not simply an individual capacity to "adapt," but participation in an organizational environment in which expectations and acceptable ways of working must be learned through interaction.

Human and organizational learning can therefore be interpreted as students' reflected awareness that professional competence is partly relational and context-dependent. Technical knowledge may enable a student to perform a task, but participation in professional practice also requires navigating people, norms, expectations, and organizational relationships. The present data do not establish that students achieved complete professional or emotional maturity; rather, they show that these human and organizational dimensions became visible in how students interpreted their internship experiences.

Theme 7: Business and Career Awareness

Business and career awareness was retained as a final theme because students' reflections extended beyond performing design and production tasks to considering the commercial environment and occupational possibilities surrounding furniture work. Two related strands were evident within this theme. The first concerned business considerations such as material availability, production cost, suppliers, consumers, operational continuity, and commercial risk. The second concerned students' recognition of career possibilities across the wider furniture-industry ecosystem. Evidence related to these areas appeared across the responses. However, the analytical interest lies in how students connected industrial experience with commercial decision-making and possible professional pathways rather than in the breadth of coverage itself. R05 illustrated the business dimension of this theme:

> *"The internship made me realize that building or managing a furniture business is much more complex than*

> *simply making a good product. ... We sometimes have to compromise when the desired material is difficult to obtain, or production costs increase. ... Running a furniture business is not only about artistic idealism, but also about managing risk, maintaining communication across teams, and making financially reasonable decisions so that the business can continue to operate."* (R05)

This account connects design with business viability. R05 described material availability, production cost, operational continuity, risk, and coordination as considerations that shape business decisions. The reflection therefore goes beyond a general interest in entrepreneurship and shows an awareness that furniture businesses must balance design intentions with resource limitations and financial consequences. Although business and career considerations were explicitly included in the questionnaire, the instrument did not prescribe this particular relationship among material constraints, cost escalation, risk, cross-functional coordination, and business continuity. That interpretation was developed from the content of the student's response. Career awareness appeared in a related but distinct way. R02 explained:

> *"Before the internship, I thought career opportunities in the furniture industry were limited to becoming a designer or furniture producer. After becoming directly involved, however, I realized that many other fields also offer significant opportunities."* (R02)

R02 subsequently identified possibilities connected with suppliers of hardware, woven and natural-fiber materials, furniture accessories, finishing materials, and other parts of the supply chain. This indicates that career awareness was not limited to identifying additional job titles; it also involved recognizing the broader industrial ecosystem surrounding furniture production. The before-after contrast in R02 is interpreted as the student's retrospective account of changed understanding rather than as evidence of longitudinally measured career development.

Taken together, these reflections suggest that students understood professional possibilities at two levels. At the business level, they recognized relationships among design, cost, material availability, production capability, customers, and commercial risk. At the career level, they recognized that professional opportunities may exist across design, production, quality, supply, supporting industries, and entrepreneurship. The two strands are connected by a broader recognition that furniture design operates within an economic and occupational system extending beyond the designer's immediate technical role. This distinguishes Theme 7 from the preceding themes: the earlier themes concern participation within the industrial work system, whereas business and career awareness concerns how students interpreted the wider opportunities and constraints surrounding that system.

This interpretation is consistent with research that positions workplace learning as a context for career exploration. Lu et al. (2024), in a study of 288 students who had completed internships, conceptualized career exploration as the process through which students seek information relevant to their future career development and showed its relationship with career adaptability in the internship context. Quintero Rodriguez et al. (2025) similarly show how work-integrated learning can be deliberately connected with career development learning so that industry engagement helps students relate disciplinary experience to career planning, professional experience, and possible employment pathways. Their study is particularly relevant to the present findings because it concerns

product-development education and demonstrates how industry-connected learning can broaden the relationship between technical preparation and career-oriented reflection.

The business strand can also be situated within recent research on entrepreneurial learning through authentic workplace experience. Yeager et al. (2026), analyzing 158 written reflections from students in an internship program with small businesses, found that authentic engagement with business contexts shaped students' interpretations of professional identity, career clarity, real-world problem-solving, and entrepreneurial learning. Although the present study does not assess entrepreneurial competence or intention, R05 similarly shows how exposure to actual operating conditions made commercial considerations such as cost, resource constraints, risk, and continuity visible within the student's interpretation of furniture practice.

Business and career awareness can therefore be interpreted as students' reflected recognition of the economic and occupational ecosystem surrounding furniture design practice. The data do not establish that internship caused students to make particular career choices or develop entrepreneurial intention. Rather, they show that students articulated a broader range of commercial considerations and professional possibilities after participating in industrial work. The relationships between this broader business and career perspective and the technical, organizational, and professional dimensions identified elsewhere in the analysis are examined through the subsequent thematic co-occurrence analysis.

Interrelationships among Thematic Dimensions

The preceding thematic sections examined each dimension separately, whereas the third research question concerns how these dimensions were connected within students' reflections. To examine these relationships more directly, thematic co-occurrence was assessed across 1,089 response units, with each participant's answer to an individual open-ended question treated as one textual segment. A co-occurrence was recorded when the same response unit was assigned codes representing two different final themes. This approach distinguishes direct thematic connection within a response from the broader respondent coverage reported Table 1.

Table 2. Thematic co-occurrence matrix across 1,089 coded response units

Theme	ISA	PODC	QEC	CCC	PWA	HOL	BCA
Industrial system awareness (ISA)	406	102	109	144	57	34	24
Production-oriented design competence (PODC)	102	279	99	49	20	11	15
Quality and efficiency consciousness (QEC)	109	99	233	62	35	6	17
Communication and coordination competence (CCC)	144	49	62	229	41	51	3
Professional work attitude and accountability (PWA)	57	20	35	41	327	118	20
Human and organizational learning (HOL)	34	11	6	51	118	263	12
Business and career awareness (BCA)	24	15	17	3	20	12	110

Table 2 shows that the most frequent co-occurrence involved industrial system awareness and communication and coordination competence (n = 144). Students frequently described the industrial system in terms of relationships among divisions, information flow, and the consequences of communication or coordination across functions. Industrial system awareness also co-occurred frequently with quality and efficiency consciousness (n = 109) and production-oriented design competence (n = 102). Together with the substantial co-occurrence between production-oriented design competence and quality and efficiency consciousness (n = 99), these patterns indicate a closely connected technical-operational cluster in which students related understanding of the wider production system to manufacturability and the consequences of design or production decisions.

A second prominent co-occurrence occurred between professional work attitude and accountability and human and organizational learning (n = 118). Responses connecting these themes often situated responsibility, discipline, adaptability, and dependability within interactions with supervisors, coworkers, feedback, workplace expectations, and pressure. This pattern suggests that students did not interpret professional accountability solely as an individual attribute; it was also embedded within the social conditions of workplace participation.

Other recurring relationships included quality and efficiency consciousness with communication and coordination competence (n = 62) and communication and coordination competence with human and organizational learning (n = 51). These connections align with students' accounts, in which unclear information, revision problems, coordination across units, interpersonal adjustment, and feedback could converge within the same workplace situation. Less frequent co-occurrence with business and career awareness suggests that this theme functioned more often as a wider commercial and occupational perspective than as an immediate component of day-to-day technical or relational situations.

The matrix is interpreted descriptively rather than statistically. The counts identify where thematic dimensions were represented together within the same response units; they do not establish correlations, causal effects, or developmental sequences. Taken together, the co-occurrence patterns provide direct empirical support for interpreting students' reflected professional learning as multidimensional and relational, while also showing that some thematic connections were substantially more recurrent than others.

■ CONCLUSION

This study explored how furniture design students articulated professional learning and industrial awareness after completing an industrial internship. Analysis of 33 post-internship reflective responses identified seven interconnected themes: industrial system awareness, production-oriented design competence, quality and efficiency consciousness, communication and coordination competence, professional work attitude and accountability, human and organizational learning, and business and career awareness. Across these themes, students described furniture design not only in relation to visual or product-making activities, but also in relation to production feasibility, material and construction decisions, quality consequences, information flow, workplace relationships, professional responsibility, and commercial considerations.

The study's main contribution is identifying industrial system awareness as an organizing context for reflected professional learning in furniture design. Students' accounts situated design within an interconnected system in which technical decisions, production capabilities, quality standards, communication, human

relationships, accountability, and business considerations were linked in different combinations. The thematic co-occurrence analysis provided additional descriptive evidence for this relational interpretation. Industrial system awareness was most frequently connected with communication and coordination competence, quality and efficiency consciousness, and production-oriented design competence. At the same time, professional work attitude and accountability showed a strong connection with human and organizational learning. These patterns support an interpretation of reflected professional learning as multidimensional and relational rather than as a linear progression from classroom knowledge to professional competence. The study does not establish that internship caused these competencies to develop; instead, it shows how students articulated and interpreted these dimensions of professional practice after their industrial experience.

For vocational furniture design education, the findings support the value of structured post-internship reflection that encourages students to examine not only what they performed during placement but also how their decisions related to production, quality, coordination, organizational relationships, and business realities. Learning activities can further strengthen these connections by incorporating discussion of production constraints, error consequences, cross-functional communication, professional accountability, and career possibilities. Such reflection can help students make explicit the relationships between design decisions and the wider technical, organizational, and professional conditions in which furniture work is carried out.

The findings should be interpreted within the boundaries of the study. The data consisted of students' written post-internship reflections from a single vocational furniture design context. They were not independently verified through workplace observation, supervisor assessment, interviews, or direct performance measures. The co-occurrence analysis was also descriptive and based on AI-assisted classification using the finalized thematic codebook; its counts indicate thematic co-presence within response units rather than statistical association or causal relationships. The study therefore provides evidence of reflected professional learning and industrial awareness rather than demonstrated workplace competence or measured developmental change. Future research could combine student reflections with supervisor perspectives, workplace observations, longitudinal data, or multiple cohorts to examine more directly how these dimensions are enacted and change across vocational learning experiences.

■ DECLARATION OF GENERATIVE AIS USAGE IN THE WRITING PROCESS

Google Translate and Grammarly were used only for language assistance, including translation support, spelling, grammar, and wording corrections. ChatGPT (OpenAI) was also used as an analytical assistant during manuscript revision to support the development and execution of an automated text-classification workflow for the thematic co-occurrence analysis. The authors established the research questions, deductive-inductive codebook, seven final themes, and substantive thematic interpretations before conducting this AI-assisted procedure. The automated analysis applied the finalized thematic framework to 1,089 response units and generated descriptive theme assignments, co-occurrence counts, and threshold-sensitivity diagnostics. AI-assisted outputs were treated as analytical aids and were checked against the established codebook and source responses rather than accepted as independent interpretations. AI tools were not used to generate research data or determine the study's conclusions. The authors reviewed the

analytical outputs and take full responsibility for the methodology, interpretation, and final content of the manuscript.

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