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Talent Development in Science and Technology Parks (STPs) Within the Context of Sustainable Education Systems: Experiential Learning and Mentorship Practices in a Phenomenological Study

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Abstract: The rise of knowledge-based economies has positioned higher education institutions as key actors in human capital development, requiring them to engage more actively with labor markets through strategic partnerships. Within this context, university-affiliated science and technology parks (STPs) have evolved into integrated learning environments that support experiential learning and mentorship practices. This study aims to explore the lived experiences of undergraduate students who participated in these processes within an STP in İstanbul, Türkiye. Using a qualitative phenomenological approach, data were collected through semi-structured interviews with 15 students selected via purposive maximum variation sampling. Thematic analysis, supported by MAXQDA 2024, was used to examine the data. Two main themes were identified: (i) talent development through experiential learning and (ii) talent development through mentorship. The findings indicate that students reconstructed theoretical knowledge through real-world applications, developed a clearer professional identity, and gained strategic career awareness. Mentorship provided both technical and psychosocial support, fostering self-confidence, emotional security, and role modeling. This study concludes that STPs play a strategic role in aligning academic learning with employability and institutional talent development goals. These results contribute to broader educational and workforce development discussions and are closely aligned with Sustainable Development Goals 4 (Quality Education) and 8 (Decent Work and Economic Growth), highlighting STPs as transformative platforms in higher education. Moreover, this study offers practical implications for aligning higher education with employment systems through structured experiential learning and mentorship practices.

Keywords: sustainability; Sustainable Development Goal 4 (SDG 4); Sustainable Development Goal 8 (SDG 8); sustainable education systems; science and technology parks (STPs); experiential learning; mentorship; talent development; strategic human resources management



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1. Introduction

The knowledge-based economies of the 21st century have necessitated a transformation in the role of higher education institutions, compelling them to move beyond merely transmitting knowledge and reposition themselves as organizations that develop sustainable human capital and contribute strategically to the labor market [1,2]. This transformation has made it essential for universities to manage their functions of education,

research, and societal engagement in an integrated manner, while also ensuring that students have access to both theoretical learning and experiential, practice-based development opportunities [3].

The evolution in higher education is directly associated with fields such as human resources management (as an organizational function), career planning (as an individual-level development process), and talent development. Talent development, in this context, refers to the strategic and pedagogical processes through which universities support students' professional growth, skill acquisition, and long-term career adaptability [4,5]. This has rendered it necessary for universities to educate graduates not only as employable individuals but also as value-creating human capital actors [6]. In this context, strategically structured talent management systems aligned with sustainability are critically important for aligning individual learning outcomes with institutional visions and regional development goals [7]. Indeed, strategic talent management at the university level is closely linked to institutional graduate profiles, employability strategies, and broader visions of societal contribution [8].

Initially established within universities to support technology development and entrepreneurship ecosystems, STPs have become key actors in this transformation. STPs were first established in the 1950s in the United States to promote university–industry collaboration and to foster knowledge-based economic development. The Stanford Research Park (1951) is widely regarded as the first example of such an initiative [9]. Today, STPs are increasingly recognized as unique educational and talent development environments that foster multilayered processes such as experiential learning, mentorship, and strategic career development [10]. With these evolving functions, STPs contribute not only to innovation and entrepreneurship outcomes but also to the sustainable governance of higher education systems, the strategic cultivation of qualified human capital, and the institutional strengthening of university–industry–government collaborations. In the context of Türkiye, university-affiliated STPs play a vital role in fostering sustainable human capital by facilitating technology transfer while simultaneously engaging young talent in experiential learning and professional development processes [11]. Recent studies further emphasize the growing strategic role of STPs in fostering innovation ecosystems and serving as talent development platforms within entrepreneurial university models [10]. Recent evidence also suggests that STPs are increasingly seen as mechanisms for enhancing learning equity, cross-disciplinary engagement, and innovation-driven employability outcomes [12].

However, the current literature has predominantly addressed the impact of STPs on student development through the lenses of entrepreneurship, technology generation, or innovation outputs, often overlooking the direct developmental effects of these environments on individuals [10,13]. In particular, there is a limited body of qualitative research that deeply investigates how students' experiential learning processes, mentorship practices, and early-stage professional roles within hybrid structures like STPs influence personal dimensions such as self-efficacy development, professional identity formation, and career orientation. Moreover, the integration of these processes into broader institutional structures—such as universities' human resources management functions, employability strategies, and sustainable education systems—has received limited scholarly attention beyond its role in individual development. Yet, these experiences foster the production of multidimensional learning outcomes and carry strategic value for higher education institutions in terms of long-term talent planning, graduate performance, and societal contribution roles [14–16].

This study adopts a qualitative and phenomenological approach to examine the subjective experiences of university students participating in experiential learning and mentorship practices within STPs. In this regard, this study departs from existing literature

(e.g., [9,10]) by focusing on students' lived developmental experiences—including their professional identity formation, career clarity, and reflective learning processes—within STPs, using a phenomenological lens that remains underexplored. This research was conducted in İstanbul, one of Türkiye's most active cities in terms of university–industry collaboration. İstanbul was selected as a high-representative context due to its dense concentration of STPs and diverse student population, which provide a multidimensional setting for observing experiential learning and mentorship practices. The main objective of this study is to evaluate how these experiences influence students' individual and professional development from the perspective of sustainable education management and strategic talent development, and to contribute to the design of structured experiential learning systems within higher education institutions. In this regard, this study reveals the potential of STPs to contribute to higher education institutions' sustainable human capital development strategies beyond individual learning, aligning with both Sustainable Development Goals—SDG 4 (Quality Education) and SDG 8 (Decent Work and Economic Growth).

Despite this promising potential, it is important to recognize that the implementation of STPs as developmental environments does not always reflect their conceptual promise. While STPs are increasingly framed as critical infrastructures for university–industry collaboration and student development, recent studies suggest that their practical effectiveness remains highly variable and, in many contexts, limited (e.g., [17]). In particular, gaps in institutional integration, mentorship design, and long-term talent strategies continue to constrain their impact beyond isolated or short-term outcomes.

Recent studies further highlight these challenges across diverse regional settings. For example, Melo et al. [18] identify mismatches between experiential learning objectives and actual student support structures in Latin American STPs. Similarly, Ćudić et al. [19] point to capacity and coordination issues in Eastern European science parks, while Rui et al. [20] document fragmented learning outcomes in Chinese STPs due to weak pedagogical frameworks. These findings underscore the need for a more critical and context-aware understanding of how STPs can be effectively embedded within higher education systems. Without such alignment, their contributions to sustainable talent development and SDG-related goals may remain aspirational rather than transformative.

The following section builds upon this background by reviewing the conceptual foundations of STPs as learning environments, with a particular focus on experiential learning and mentorship as strategic components of talent development.

1.1. STPs and Sustainable Talent Development in Higher Education: A Conceptual Framework

1.1.1. The Role of STPs in Sustainable Education Systems

STPs emerged in the mid-20th century as structures aimed at institutionalizing university–industry collaboration [9]. Over time, their functions have expanded beyond supporting research and development (R&D) processes to encompass multifaceted goals such as entrepreneurship, talent development, technology transfer, and regional development [21–23]. Today, STPs serve not only as physical infrastructures but also as multiactor learning environments positioned at the center of universities' third mission function—namely, societal contribution [24]. Through these functions, STPs contribute to knowledge production as well as to advancing lifelong learning, applied skill development, and employability—key objectives aligned with sustainable education systems [25,26]. In line with updated international policy perspectives, recent reports such as UNESCO's 2021 [27] policy framework emphasize the need for integrating flexible, inclusive, and practice-oriented models into sustainable education systems—many of which align closely with the learning environments fostered within STPs. Similarly, the OECD's Education

Policy Outlook 2021 [28] highlights the importance of building resilient and future-ready education systems through policy approaches that support responsive curricula, digital and hybrid learning pathways, and stronger connections between education and labor markets. These structures provide individuals with practice-based and experiential learning environments that extend beyond the university years into their professional lives [29], thus supporting the development of employability indicators such as technical competence, problem-solving, communication, strategic thinking, and sectoral adaptability [30].

At this point, STPs are no longer viewed solely as centers of technology production, but rather as “learning ecosystems” that support the social, cognitive, and managerial dimensions of learning at individual, institutional, and regional levels [31]. The concept of learning ecosystems is used to explain how continuous learning processes are shaped through the interaction of actors, the circulation of knowledge, cultural norms, and institutional structures [32]. In this regard, STPs serve as platforms that facilitate the production and transfer of knowledge while also acting as integrated environments that support individual professional development, enhance institutional strategic learning capacities, and foster regional innovation dynamics simultaneously [7]. In particular, in structures where universities, research institutes, and firms coexist, learning takes place in multifaceted ways—individually, institutionally, and systemically [2,3].

These multiactor learning models offer practical responses to sustainable education approaches that prioritize flexibility, inclusivity, and continuous professional development within education systems. From this perspective, STPs are structurally aligned with the SDGs, particularly SDG 4 and SDG 8 [25,26]. Indeed, STPs enable individuals to develop academic competencies alongside professional, social, and behavioral skills [7] while simultaneously supporting universities in building sustainable learning environments that align with graduate profiles, employment strategies, and societal engagement missions [24]. Through mechanisms such as experiential learning and mentorship, STPs extend learning processes into a lifelong development framework—thus enhancing individual employability and contributing to the institutional adoption of inclusive and flexible educational models [25].

Lecluyse et al. [23] present a comprehensive model that conceptualizes the impact of STPs on learning at micro, meso, and macro levels. At the micro level, students, researchers, and entrepreneurs develop not only technical skills but also social and behavioral competencies within the STP environment [33]. At the meso level, collaboration networks among universities, industry actors, and public institutions expand, enhancing knowledge sharing and innovation capacity [10]. At the macro level, STPs serve as the core of regional innovation systems, contributing to knowledge-based economic growth and sustainable development [20,34].

Through these multilayered functions, STPs are closely aligned with the Triple Helix model, which conceptualizes the interaction among university, industry, and government sectors [3]. Within the Triple Helix framework, STPs operate as hybrid spaces for learning and innovation at the intersection of distinct institutional logics: universities support the system through knowledge production and talent development capacity; industry contributes through application and commercialization dynamics; and the government provides regulatory and incentivizing mechanisms [2,13]. This integrated structure supports students’ professional development at the individual level, while at the institutional level, it enables universities to go beyond traditional academic instruction by embedding sustainable skill-building, sectoral alignment, and strategic talent management into their human resource development functions. In doing so, STPs are positioned as mechanisms that strengthen the long-term human capital strategies of higher education institutions and offer structural contributions to the advancement of sustainable education systems [1,25].

On the other hand, critical literature indicates that not all STPs are equally effective in fulfilling these functions. Factors such as the level of political support, institutional capacity, the organic linkage between the university and the STP, and the existence of structured human resources management strategies are cited as key determinants of the quality of learning outcomes [23]. For example, Glittová and Šipikal [17] note that although university-based STPs in Slovakia are strong in terms of physical infrastructure, they remain weak in areas such as institutional capacity, financial sustainability, and human resources management. Similarly, Link and Scott [9] show that some STPs in the United States maintain primarily symbolic connections with universities and fail to establish structurally integrated learning relationships. In the context of Türkiye, studies on STPs reveal that, although infrastructure investments have increased in recent years, there remains a need for institutional development, particularly in the systematic structuring of experiential learning, mentorship practices, and strategic talent management processes [11]. Furthermore, studies highlight that while many STPs host student internships and experiential projects, these are often carried out on a short-term, project-based basis and are not fully integrated into long-term talent development or career planning frameworks [35].

1.1.2. Talent Development Through Experiential Learning

Talent development is defined as a multidimensional process that involves not only enhancing existing skills but also systematically supporting individuals' learning capacities through environmental, social, and cognitive engagement in today's knowledge-based economies [4,36]. Particularly during higher education and early career stages, talent development is shaped by a combination of institutional support mechanisms, access to learning resources, and real-world exposure [5].

In recent years, experiential learning has gained renewed importance as a response to the limitations of traditional instructional methods. The COVID-19 pandemic, in particular, accelerated the adoption of digital and hybrid experiential learning models, which now coexist with traditional in-person applications [37,38]. These hybrid approaches emphasize active involvement, contextual engagement, and reflective learning processes, enabling students to integrate knowledge in dynamic ways. Kolb's [15] experiential learning theory remains foundational, conceptualizing learning as a cycle involving concrete experience, reflective observation, abstract conceptualization, and active experimentation. Similarly, Eraut [39] and Raelin [40] highlight the centrality of work-based and informal learning environments in fostering professional growth, especially in contexts where learning emerges through doing and reflection-in-action.

Recent empirical studies have expanded these classical models to include digital and post-pandemic learning environments. For example, Deng and Yu [38] underscore how virtual simulations and hybrid projects can offer meaningful experiential learning outcomes when properly designed. Garg [37] notes that post-pandemic learners value autonomy, purpose, and application-oriented learning more than before, especially in fields like engineering and business. In this evolving context, science and technology parks (STPs) represent fertile grounds for experiential learning, particularly through real-life tasks, interdisciplinary projects, and early-stage innovation exposure [41].

STPs provide natural contexts for experiential learning by enabling students to work within actual startup or R&D ecosystems. These environments help students reconstruct theoretical knowledge, adapt to practical constraints, and acquire skills through problem-solving and team-based responsibilities [17,33]. For instance, Cadorin et al. [41] found that students engaged in science park projects developed a stronger sense of agency, while Smith-Ruig [33] reported that field-based experiences improved both technical proficiency and decision-making confidence.

Furthermore, hybrid and remote project-based learning models—now more common post-2020—can reinforce the flexibility and adaptability of experiential learning. In a recent study, Rui et al. [20] demonstrated that blended environments within STPs enhanced the transfer of learning across contexts by exposing students to multiple modes of interaction. Thus, experiential learning in STPs is not limited to physical task execution but also encompasses reflective thinking, digital collaboration, and cross-disciplinary problem-solving, all of which align with broader SDG objectives, such as SDG 4 and SDG 8.

1.1.3. Talent Development Through Mentorship

Mentorship practices are considered important developmental mechanisms that integrate the social, cognitive, and professional dimensions of learning. Particularly for university students and individuals in the early stages of their careers, mentorship facilitates the transition from theoretical learning to practical skills, and from knowledge acquisition to professional identity formation [42,43]. In this regard, mentorship is a reciprocal learning relationship that supports individuals in both career development and psychosocial well-being [44]. Mentorship practices implemented within higher education contexts have been shown to make meaningful contributions to students' academic success, professional orientation, and preparedness for entering the labor market [33]. Recent meta-analytical evidence further confirms the positive impact of mentorship in higher education on students' academic, emotional, and professional outcomes, particularly in structured institutional settings [45]. This reinforces the findings observed in STP-based mentorship relationships examined in this study.

The learning outcomes of mentorship are not limited to the acquisition of knowledge. These relationships enhance individuals' levels of self-efficacy [14], support learning motivation [46], and strengthen social capital by providing access to professional networks [47]. Mechanisms such as personalized guidance, role modeling, and feedback reveal how the mentorship practices support the interactive and contextual dimensions of learning [48,49]. A study conducted by Cavanaugh et al. [50] further indicates that mentorship reduces workplace burnout and increases overall job satisfaction.

Mentorship practices implemented within STPs serve as a bridge between universities and the industry, contributing to students' development both on an individual and professional level [10,41]. Glittová and Šipikal [17] demonstrate that in STP environments, students are integrated into project teams through mentors and engage in active learning processes via interactions with experts. Huang-Saad et al. [51] also report that student-mentor pairings within the I-Corps program support not only the acquisition of technical knowledge but also the development of higher-order cognitive processes such as entrepreneurial thinking, decision-making capacity, and risk management. These experiences enable students to improve not only their technical competencies but also their ethical awareness, communication skills, and leadership capabilities.

Key factors influencing the effectiveness of mentorship practices include matching strategies, the quality of the mentorship, the institutional support structure, and cultural fit [46]. An effective mentorship is typically characterized by mutual trust, openness, and a focus on development, whereas poorly structured processes can lead to negative outcomes such as mistrust, role ambiguity, and power imbalances [44].

Mentorship is widely recognized as a key developmental process that integrates the technical, social, and emotional dimensions of learning. Particularly for university students transitioning to the labor market, mentorship serves as a bridge between academic preparation and professional practice, facilitating both identity formation and employability [3,42,43]. Traditional models emphasize mutuality, role modeling, and developmental guidance, often within face-to-face relational contexts [46,47]. However, recent studies have

shown that the mentorship landscape has been significantly reshaped in the aftermath of the COVID-19 pandemic [52].

Digitalization, remote work structures, and increased flexibility in professional settings have contributed to the rise of virtual and hybrid mentorship models, enabling broader access, diversified interaction styles, and asynchronous support [38]. Cavanaugh et al. [50] note that mentorship formed in digital contexts can still deliver high emotional and professional value, particularly when structured around shared goals, psychological safety, and interactive feedback loops. Similarly, Sambunjak et al. [53] emphasize that the quality of connection—rather than physical proximity—is the key driver of mentorship effectiveness in hybrid environments.

Within the context of STPs, mentorship often emerges organically through collaboration in innovation projects or startup teams. These relationships serve both instructional and developmental functions. For instance, students are not only guided in completing tasks but are also exposed to models of professional conduct, decision-making, and leadership [10,17,48]. Huang-Saad et al. [51] illustrate that structured mentor–mentee pairings in innovation programs such as I-Corps foster the development of higher-order competencies such as entrepreneurial thinking, decision-making, and risk assessment—skills that are increasingly vital in dynamic, post-pandemic labor markets.

Moreover, post-2020 literature suggests that mentorship fosters resilience, self-efficacy, and adaptive career thinking, especially among early-career professionals navigating uncertain futures. Garg [37] and Xu et al. [54] argue that in rapidly changing environments, mentorship provides stability, motivation, and identity scaffolding—making it a strategic human resource tool for both educational institutions and innovation-driven firms. In this light, STPs serve not only as technical incubators but also as developmental ecosystems where mentorship supports long-term career construction.

Importantly, mentorship can be conceptually embedded within Kolb's [15] experiential learning cycle to demonstrate how mentor–mentee interactions support all four stages of the learning process. During concrete experiences, mentors expose students to authentic workplace tasks; in the reflective observation stage, they guide critical self-assessment and meaning-making through feedback; during abstract conceptualization, mentors help mentees reframe experiences into generalized knowledge or professional heuristics; and in the active experimentation phase, they encourage mentees to apply revised strategies in new contexts. This integrative perspective positions mentorship not merely as an external support mechanism but as a developmental engine that accelerates and deepens experiential learning. Accordingly, the conceptual model presented in Figure 1 visualizes how mentorship dynamics interact with each stage of Kolb's [15] experiential learning cycle, positioning mentors as active agents in the transformation of experience into learning—and ultimately into professional identity and competence.

Finally, effective mentorship in STPs is closely linked to structured institutional design. Studies recommend intentional mentor–mentee matching, role clarity, and evaluation mechanisms to ensure developmental alignment [44,55]. When mentorship is integrated into broader institutional strategies—such as alumni tracking systems, employability initiatives, or competency-based certification programs—it significantly enhances its developmental value and contributes to the strategic advancement of sustainable education systems.

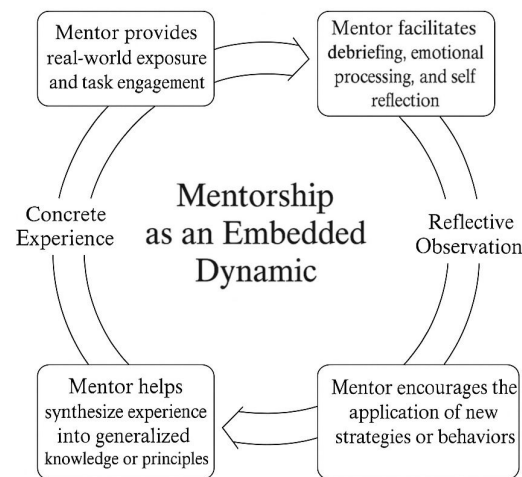


Figure 1. Mentorship-integrated experiential learning cycle.

2. Materials and Methods

2.1. Research Design

This study was designed in accordance with the phenomenological approach, one of the qualitative research methods. Phenomenology is a research approach that focuses on understanding how individuals experience a particular phenomenon and the meanings they assign to those experiences [56,57]. This method particularly aims to reveal the “essence” of lived experience by deeply engaging with the participant’s narrative world and analyzing the layers of meaning. In phenomenological research, it is essential for the researcher to bracket their own preconceptions and to understand the participants’ experiences from their perspective [58].

The primary aim of this study is to explore university students’ subjective experiences regarding the experiential learning and mentorship they engaged in within STPs, and to uncover the meanings they attach to these experiences. These environments represent multifaceted learning contexts for students, not only for acquiring technical skills but also for the development of professional identity, career orientation, and social belonging [15,40]. Accordingly, this study aims to explore both the participants’ lived experiences within these contexts and the meanings they constructed through those experiences.

The phenomenological approach offers a suitable methodological foundation for addressing such meaning-oriented, contextual, and experiential research questions. The meanings that students ascribe to their experiences, the perceived effects of those meanings on personal and professional development, and the individual traces left by these experiences will be examined through qualitative data. In this regard, phenomenology—with both its descriptive and interpretative dimensions—serves as a methodologically appropriate choice for the nature of this study [59]. The flexible yet in-depth nature of this method allows for the analysis of participants’ narratives beyond the surface level.

2.2. Participants

The sample of this study consists of undergraduate students who directly participated in experiential learning and mentorship practices within a single STP affiliated with a public university in İstanbul, Türkiye. İstanbul was selected as the research site due to its role as a major metropolitan hub where university–industry collaboration is most intensively realized, and where a high concentration of STPs and entrepreneurship support mechanisms exists. Furthermore, the city offers one of the most diverse higher education environments in Türkiye in terms of academic disciplines and student population, providing fertile ground for experiential learning and mentorship opportunities.

As emphasized in the literature, meaningful learning outcomes from experiential learning and mentorship require a certain level of temporal depth [15,39,60]. Accordingly, a key criterion for participation was that students must have been actively involved in STP activities for at least one academic semester (approximately 4 to 8 months).

Data collection was completed within five days during a short academic break, which allowed for the efficient scheduling of interviews. Although the timeframe was limited, all 15 interviews were pre-arranged and successfully conducted, ensuring that the targeted sample size was reached without compromising data quality.

Given that the aim of this study was to understand students' subjective experiences related to these processes and the effects of those experiences on individual learning, skill development, and the formation of professional identity, the sample was constructed using the purposive sampling method, specifically the maximum variation strategy [56,61]. Participants were selected to ensure diversity in variables such as learning styles, age, gender, academic discipline (e.g., engineering, business, social sciences), and year of study. Their modes of participation included a range of experiences such as short-term internships, project-based fieldwork, research assistantships, mentorship practices, or student entrepreneurship.

In total, in-depth semi-structured interviews were conducted with 15 participants (Table 1). The interviews were conducted on a voluntary basis and designed to ensure participants' privacy and freedom of expression. In line with the widely cited principle of "data saturation" in qualitative research, the number of participants was deemed sufficient once thematic repetition began to occur, at which point the data collection process was concluded [62]. Thus, the sample reached a level that was sufficient in both depth and representativeness, in accordance with the phenomenological nature of this study, and was concluded based on principles of thematic saturation observed during the later stages of data collection.

Table 1. Participant Profile.

Code	Gender	Department	Academic Year	Type of Experience	Role in the STPs	Duration (Months)
K1	Female	Industrial Engineering	4	Entrepreneurship Project	Co-founder (Business Development)	6
K2	Male	Business Administration	3	Internship + Mentorship	HR Intern and Mentorship Mentee	4
K3	Female	Electrical and Electronics Engineering	4	R&D Project Assistantship	Project Assistant	5
K4	Male	Computer Engineering	3	Start-up Technical Team	Software Development Support Staff	8
K5	Female	Molecular Biology	2	Laboratory Observation Internship	Molecular Analysis Observer	3
K6	Male	International Trade	4	Mentorship + Project Planning	Marketing Strategy Support Personnel	6
K7	Female	Mechatronics Engineering	3	Robotics Applied R&D	Mechanical Prototyping Technician	7
K8	Male	Electrical and Electronics Engineering	2	Summer Internship	Hardware Assembly Intern	2

Table 1. *Cont.*

Code	Gender	Department	Academic Year	Type of Experience	Role in the STPs	Duration (Months)
K9	Female	Psychology	4	Mentorship Program	Co-mentor Facilitator	5
K10	Male	Political Science	3	Field Research + Analysis	Field Researcher	4
K11	Female	Software Engineering	2	Incubation Center Participation	Software Support Specialist at Incubation Startup	6
K12	Male	Business Administration	4	Project-Based Consultancy	Business Model Development Officer	5
K13	Female	Chemical Engineering	3	Mentorship + Laboratory Practice	Chemical Process Observation Assistant	4
K14	Male	Economics	4	Data Science Project	Data Analytics Assistant	6
K15	Female	Civil Engineering	3	Start-up Project	Field Simulation Support Technician	5

In this regard, data saturation was monitored iteratively throughout the analysis process. Saturation was determined when no new codes, categories, or thematic structures emerged in the final set of interviews. In particular, sub-themes such as “transfer of theoretical knowledge into practice”, “emotional safety in mentorship”, and “career orientation clarity” consistently recurred across participants starting from the 11th interview onward. These thematic repetitions indicated that additional interviews were unlikely to yield novel conceptual insights. Therefore, the decision to conclude data collection after 15 interviews was based on the convergence of thematic codes and the redundancy of experiential content. This approach aligns with Guest et al.’s [62] and Lincoln and Guba’s [63] widely accepted saturation principles in qualitative inquiry.

2.3. Data Collection Strategy

The data for this study were collected through semi-structured in-depth interviews developed in line with the research questions. The semi-structured interview technique is widely preferred in qualitative research as it provides a thematic framework while allowing for flexibility [64]. This method enabled the emergence of detailed, contextual, and subjective narratives regarding the participants’ experiences.

The interview form was structured based on a literature review and the objectives of this study to cover core themes such as experiential learning and mentorship. The development process of the form followed the recommendations proposed by Kallio et al. [65] for designing semi-structured interview guides. This process included the following steps: (i) clearly defining the research objectives and key questions, (ii) identifying relevant themes, (iii) developing open-ended questions, (iv) formulating probing follow-up questions, (v) organizing the questions in a logical order; (vi) conducting a pilot interview to test content validity; and (vii) finalizing the interview form based on feedback received (see Appendix A).

The data collection process took place between 15 April 2025 and 20 April 2025. The interviews were conducted either face-to-face or via online platforms (e.g., Zoom, Google Meet), depending on participant preference. Each interview session lasted approximately 40 to 55 min, was audio recorded with participant consent, and subsequently transcribed verbatim for inclusion in the analysis.

During data collection, care was taken to conduct the interviews in an open and nonjudgmental atmosphere. The researcher avoided being directive and preserved the authenticity of participant narratives while using exploratory sub-questions to deepen the discussions and support the narrative integrity.

In accordance with ethical principles, participants were informed in advance about the purpose, scope, and confidentiality terms of this study, and verbal informed consent was obtained. Participants were explicitly assured that the information they provided would be kept confidential and that they could withdraw from the study at any time. The entire data collection process was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki, and this study was approved by the Ethics Committee of Beykoz University (Ethics Approval No: 1, Date: 14 April 2025).

2.4. Data Analysis and Thematic Categorization

The data obtained in this study were analyzed through thematic analysis, a widely used method for identifying, understanding, and reporting patterns in qualitative data. Thematic analysis offers a systematic yet flexible analytical framework, especially suitable for phenomenological research that aims to structure and interpret subjective experiences [66]. In this study, thematic analysis was conducted within a factist epistemological framework, which adopts a descriptive approach based on the representation of reality; data were treated as meaningful indicators reflecting participants' lived experiences [67].

The analysis followed the six-phase structure proposed by Braun and Clarke [66]: (i) familiarization with the data—repeatedly reading the transcripts to grasp the general structure of meaning, (ii) generating initial codes—systematically coding meaningful units within participant narratives, (iii) constructing themes—grouping codes by content similarity to develop initial themes, (iv) reviewing themes—assessing coherence of themes with coded data and the broader dataset, (v) defining and naming themes—assigning conceptual titles that reflect the unique meaning of each theme, (vi) producing the report—presenting findings within a thematic structure, supported by illustrative quotations and interpreted in relation to the literature.

An inductive (data-driven) coding strategy was adopted throughout the analysis. Codes and themes were derived inherently from participant narratives without adhering to any predefined framework. Data organization and coding were conducted using MAXQDA 2024 software, which enabled the systematic visualization and integrated management of codes, themes, and participant linkages. Themes were interpreted through the lens of Van Manen's [57] phenomenological approach, which prioritizes the recognition and articulation of meaning-bearing experiential units. Here, a theme refers not merely to frequently repeated patterns but to contextually integrated structures of meaning that reflect the essence of narratives.

To ensure the reliability and confirmability of the analysis process, four transcripts were initially coded independently by two researchers. Based on these initial codes, a shared codebook was developed. The remaining data were analyzed using this codebook, with cross-checking and comparative interpretation conducted throughout the process. Themes were jointly reviewed for inter-code consistency and content validity and were refined as necessary until finalized. The entire process was carried out in alignment with Lincoln and Guba's [63] widely cited principles of dependability, confirmability, and interpretive coherence in qualitative research.

As an illustration of the coding logic, the sub-theme "Transfer of Theoretical Knowledge into Practice" was constructed by clustering inductively derived codes such as "learning through real tasks", "testing knowledge in the field", and "comprehension through application". These codes were consistently observed across participant narratives and

grouped due to their conceptual proximity in illustrating how students applied theoretical knowledge in real-world settings. This structure also reflects Kolb's [15] notion of "active experimentation", linking inductive data patterns with theoretical interpretation.

This example demonstrates how the thematic structure was developed through an interplay between inductive coding and theoretical grounding. The sub-themes were not formed solely based on recurring data patterns but were analytically anchored in the theoretical framework introduced earlier. For instance, Kolb's [15] experiential learning cycle informed the interpretation of experiential learning codes such as "learning through real tasks" and "comprehension through application", while Raelin's [40] work-based learning model shaped the construction of themes related to reflective dimensions in mentorship. Thus, the themes represent a structured operationalization of theoretical concepts into the lived experiences of participants.

3. Findings

This section presents the findings based on the thematic analysis of the interview data collected from participants. As a result of the analysis process, two main themes were identified (Table 2). Each theme was constructed around participants' lived experiences regarding experiential learning, mentorship, and work-based learning processes. The themes encompass multilayered patterns of experience that reflect both individual and professional development. Within each theme, representative participant quotations and their phenomenological interpretations are provided.

Table 2. Themes, Sub-Themes, and Codes.

Main Themes	Sub-Themes	Codes
Main Theme 1: Talent Development through Experiential Learning	1.1. Transfer of Theoretical Knowledge into Practice	(i) Learning through real tasks (ii) Testing knowledge in the field (iii) Comprehension through application
	1.2. Deepening of Learning through Experience	(i) Development of flexible thinking (ii) Awareness of knowledge (iii) New learning strategies
	1.3. Concretization and Retention of Learning	(i) Internalization of knowledge (ii) Emotional engagement through application (iii) Memorability
	1.4. Professional Identity and Role Awareness	(i) Feeling like an employee (ii) Taking responsibility (iii) Role integration within the team
	1.5. Career Orientation and Transformative Awareness	(i) Discovery of vocational interest/disinterest (ii) Clarification of future plans (iii) Development of self-awareness
Main Theme 2: Talent Development through Mentorship	2.1. Technical and Psychosocial Guidance from the Mentor	(i) Task-oriented guidance (ii) Encouragement to ask questions (iii) Support for self-confidence
	2.2. The Mentor as a Role Model	(i) Observation of professional behavior (ii) Behavioral modeling (iii) Aspiration to assume similar roles
	2.3. Trust and Openness in the Mentorship	(i) Open communication (ii) Emotional safety (iii) Learning without judgment
	2.4. The Relationship between Mentorship and Career Orientation	(i) Career guidance (ii) Raising awareness (iii) Offering alternative pathways

3.1. Main Theme 1: Talent Development Through Experiential Learning

Main Theme 1—talent development through experiential learning—includes five sub-themes: transfer of theoretical knowledge into practice, deepening of learning through experience, concretization and retention of learning, professional identity, and role awareness, career orientation, and transformative awareness. This theme operationalizes Kolb’s [15] notion of “active experimentation” and Eraut’s [39] emphasis on “contextual learning.” The sub-codes reflect how students restructured abstract knowledge through direct engagement in authentic tasks.

The following table (Table 3) summarizes all sub-themes and corresponding codes identified under Main Theme 1. Each code is presented with its sub-theme, representative quotes, and observed frequency.

Table 3. Thematic Synthesis of Codes under Main Theme 1.

Sub-Themes	Codes	Representative Quotes	Frequency (n = 15)
1.1. Transfer of Theoretical Knowledge into Practice	(i) Learning through Real Tasks	P3: “Setting up the circuit wasn’t just an experiment—it affected a part of the final product. That made me much more careful. You learn differently with that kind of responsibility.” P6: “Preparing a sample budget at a desk is one thing, but creating a real cost sheet is something else entirely. Knowing it would be presented made it so exciting for me. I tried really hard not to make mistakes—and that’s when I truly learned.”	10/15
	(ii) Testing Knowledge in the Field	P5: “In the university lab, everything was sterile and orderly. But where we worked here, materials were limited. Still, adapting a method even with limited resources was really exciting—it was a first for me.” P12: “In class, we always had assumptions like ‘the customer will behave like this’ or ‘the market works like that.’ But there was no such clarity in the real data. I had to try many different things just to figure out what to do.”	8/15
	(iii) Comprehension through Application	P4: “It wasn’t just about writing the code. First, I had to plan it, then test it. In our classes, we learned each of these steps as separate topics each week, but here they were all integrated.” P11: “I knew the code structure, but I learned when, where, and how to use it in the field. The code I wrote didn’t work in one of the modules, and it took me two days to figure out why—but I’ll never forget it again.”	9/15

Table 3. Cont.

Sub-Themes	Codes	Representative Quotes	Frequency (n = 15)
1.2. Deepening of Learning through Experience	(i) Development of Flexible Thinking	P6: “The budget allocated for the project was insufficient. We quickly had to develop another formula. At first, I panicked, but then I witnessed how our team came together to find a solution and implemented it. It was a completely different experience—a hard lesson that plans can change at any moment.” P10: “When the dataset was updated, I had to delete half of the report. I was frustrated at first, but then I restructured it using different sources. That’s when I realized you have to adapt quickly—giving up wasn’t an option.”	9/15
	(ii) Awareness of Knowledge	P3: “I knew the formulas, but when I was assembling the circuit, some values didn’t match the theory. It made me rethink everything. You need to make adjustments based on the real situation.” P5: “I had memorized some analysis methods, but here I couldn’t decide when to use which one. I had to go back and really learn to understand them.”	7/15
	(iii) New Learning Strategies	P5: “There was someone working next to me who constantly explained how he thought. Honestly, that was a big advantage for me. By observing and listening to him, I changed my own methods. I even take notes differently now.” P8: “I realized that memorizing everything from start to finish, like I’ve done throughout my education, doesn’t work. When there’s an error in the code, you have to carefully read the specific documentation and look at examples others have created.”	8/15
1.3. Concretization and Retention of Learning	(i) Internalization of Knowledge	P1: “Once I became responsible for the work, I realized I started to think about what I had learned actually meant.” P3: “The formula was no longer just a formula. Once I used it, I could see what it was really for. That’s why it becomes impossible to forget.”	10/15
	(ii) Emotional Engagement through Application	P2: “When I was giving my presentation and my supervisor made eye contact with me and actually listened to what I was saying, I felt so happy. It felt completely different to realize that what I had learned was actually useful.” P7: “What I did in the assembly was just fixing a small part but seeing that part working in the end made me really happy. It was the first moment I could say, ‘I did this.’”	9/15

Table 3. Cont.

Sub-Themes	Codes	Representative Quotes	Frequency (n = 15)
1.3. Concretization and Retention of Learning	(iii) Memorability	P3: “No matter how many times we studied circuit connections for exams at the university; we would forget them. But what I struggled with in a real project is still in my mind. When you make a mistake and fix it, you don’t forget it.” P6: “A mistake I made in a budget analysis taught me a lot. I never forgot to check that point in the next three reports. That incident is etched into my memory.”	9/15
	(i) Feeling like an Employee	P11: “I participated in the meetings about the software we were developing, just like everyone else. They didn’t differentiate—they included me in the whole process. That gave me a full understanding of the project from start to finish.” P12: “I was surprised when I was invited to the meeting. I was only expected to observe, but they asked for my opinion—and what I said was taken seriously. That’s when I truly felt I was part of the work.”	10/15
1.4. Professional Identity and Role Awareness	(ii) Taking Responsibility	P1: “The deadline for the project presentation was fixed. We had to finish it on time. Unlike in classes, there were no extensions. It felt like a real job responsibility.” P5: “Mixing the samples was easy, but it could affect the entire outcome. If I hadn’t been careful, the whole process would have been ruined. It was stressful, but also very instructive for me.”	9/15
	(iii) Role Integration within the Team	P3: “At first, it wasn’t clear who was doing what. But once it was established that I was in charge of testing the electrical circuits, things changed. The team began to recognize me in that role—and I started to recognize myself that way, too.” P6: “I was organizing the meetings. I handled scheduling and content sharing. Because of that, the team didn’t just see me as a student, but as someone who coordinated the work.”	8/15
1.5. Career Orientation and Transformative Awareness	(i) Discovery of Vocational Interest/Disinterest	P5: “I realized that lab work wasn’t as suitable for me as I had thought. I found that I’m more drawn to dynamic jobs that involve social interaction.” P14: “At first, it seemed like an interesting job, but when I got into the application, I realized it didn’t appeal to me. Office work wasn’t as satisfying as I had expected.”	10/15

Table 3. *Cont.*

Sub-Themes	Codes	Representative Quotes	Frequency (n = 15)
1.5. Career Orientation and Transformative Awareness	(ii) Clarification of Future Plans	P3: “I kept wondering whether system design or software was more suitable for me. Here, I worked mainly on hardware, but I felt more comfortable in software. Now I want to move in that direction.” P6: “I was torn between marketing and finance. Here, I worked with the marketing team, and I’ve made my decision—this field suits me better.”	8/15
	(iii) Development of Self-Awareness	P2: “I realized I need to be more open in communication. I used to get defensive when receiving feedback—now I’m learning to manage that.” P9: “I got really excited—and even a bit anxious—during my first interaction with a client. I love this field, but I realized I need to improve my stress management.”	9/15

3.1.1. Transfer of Theoretical Knowledge into Practice

The first sub-theme emerging within Main Theme 1 highlights how the STP experience provided students with opportunities to apply theoretical knowledge acquired at university in real-world work settings. Participants reported that they restructured their theoretical knowledge in practical contexts, tested it in the field, and developed a deeper understanding through hands-on tasks. The key codes supporting this sub-theme were learning through real tasks, testing knowledge in the field, and comprehension through application.

- Learning through Real Tasks

Participants emphasized that one of the most distinctive aspects of the STP experience was being part of a real task. This indicated that learning did not occur solely through information transfer or observation but rather through direct contribution to concrete tasks with measurable outcomes. Particularly, the experience of “assuming authentic responsibility” and “being part of productivity” was noted as a deepening and transformative aspect of learning.

- Testing Knowledge in the Field

Participants stated that when they had the opportunity to apply previously learned theoretical knowledge in the STP environment, they felt the need to test the validity of that knowledge and reconstruct it. This led them to re-evaluate knowledge not as memorized content but as context-dependent and application-oriented structures. Participants also observed that knowledge tested in the field often operated more flexibly—or at times incompletely or differently—than assumed in the classroom environment.

- Comprehension through Application

Participants expressed that they truly “understood” certain concepts for the first time through the concrete tasks and projects they undertook during their STP experiences. They stated that the application process contributed to the meaningful assimilation of previously abstract knowledge, clarified conceptual frameworks, and enhanced their level of cognitive awareness. In contrast to traditional content-delivery-based educational processes, participants highlighted that hands-on experience enabled them to generate knowledge through direct engagement and transform it into deeper understanding.

3.1.2. Deepening of Learning Through Experience

Another prominent sub-theme under Main Theme 1 concerns the learning strategies developed by participants in response to uncertainty, problem-solving demands, and dynamic conditions encountered within the STP environment. Participants indicated that they not only applied knowledge in an experiential context but also engaged in a learning process that involved questioning, transforming, and restructuring that knowledge. The primary codes supporting this sub-theme were the development of flexible thinking, awareness of knowledge, and new learning strategies.

- Development of Flexible Thinking

Participants reported that they were often required to generate their own solutions when faced with uncertain, variable, or unpredictable situations within the STP. This process contributed to moving away from viewing previously learned knowledge as fixed truths and instead fostered the ability to develop context-sensitive and situation-specific solutions. Participant narratives indicate that learning through experience not only enhanced their knowledge base but also developed their capacity for flexible and adaptive thinking.

- Awareness of Knowledge

Participants expressed that during their time at the STP, they realized that the knowledge they had previously believed they understood theoretically often differed in practice or proved insufficient. This awareness allowed them to re-question and test their knowledge within context, and to develop a more critical perspective on the learning process. They also noted that learning often requires revisiting assumptions and cultivating a deeper understanding of knowledge itself.

- New Learning Strategies

Participants noted that their experiences in the STP often challenged the learning methods they had previously relied on. They stated that these experiences compelled them to develop new strategies and, particularly in the face of uncertainty, time pressure, or technical difficulties, they restructured their learning processes to devise more effective problem-solving methods. Accordingly, the participant narratives reveal that learning is not merely the acquisition of knowledge, but also a process of “learning how to learn”, in which individuals reflect on and enhance their personal learning strategies.

3.1.3. Concretization and Retention of Learning

The next sub-theme that emerged under Main Theme 1 highlights how the STP experience enabled participants to form a more concrete, internalized, and lasting relationship with knowledge, moving the learning process beyond simple acquisition. Participants reported that engaging in real projects and producing tangible outputs significantly increased their level of involvement in the learning process and facilitated the long-term retention of theoretical knowledge. Key findings related to this sub-theme are grouped under the following areas: internalization of knowledge, emotional engagement through application, and memorability.

- Internalization of Knowledge

Participants expressed that the knowledge they acquired during their STP experiences became more personal, meaningful, and internalized when combined with tasks, applications, and responsibility. They noted that this internalization helped them understand not only what they were learning but also why and how they were learning it, revealing that learning is not just a cognitive process but also one that involves emotional and contextual dimensions.

- Emotional Engagement through Application

Another noteworthy dimension in participants' experiences was the emotional engagement that emerged during the application process. Participants described how their responsibilities, their roles within teams, the tangible outcomes of their work, and the visible impact of their contributions all created a multidimensional interaction that added an emotional layer to the learning process. This emotional connection made knowledge more meaningful and longer-lasting.

- Memorability

Participants stated that the knowledge they acquired through their STP experiences was not just momentary but retained in long-term memory, frequently recalled in practice, and influential in shaping subsequent learning processes. They emphasized that this form of learning had a qualitatively different character than the retention of theoretical knowledge; since it was grounded in lived experience, access to information became easier, and its memorability stronger.

3.1.4. Professional Identity and Role Awareness

Another important sub-theme under Main Theme 1 is the development of professional identity and role awareness during the experiential process. The STP experience not only helped participants acquire technical skills but also positioned them as active, responsible individuals within a professional work environment. Participants reported that taking on defined roles within teams, making direct contributions to tasks, and being visible actors in the process transformed their perceptions of professional identity. The key codes supporting this sub-theme were feeling like an employee, taking responsibility, and occupying a role within the team.

- Feeling Like an Employee

Participants reported that, during their time at the STP, they felt less like students and more like actual members of the professional workforce. Taking on real tasks, actively contributing to team efforts, and being accountable for the outcomes of their work made them feel positioned as "employees" rather than learners. This experience extended beyond technical skill acquisition and contributed significantly to the development of a professional identity.

- Taking Responsibility

Participants stated that the tasks they undertook during their STP experience required real responsibility. Actively participating in processes such as decision-making, task planning, error management, and meeting deadlines led them to feel more professionally grounded. The experience of taking on responsibility enabled participants to move beyond their student identity and develop a mindset more aligned with professional work life. For many, this was described as a turning point in their construction of professional selfhood.

- Role Integration within the Team

Participants expressed that assuming specific roles within teams throughout the STP process contributed to their sense of visibility and accountability as individuals. They noted that task delegation in project teams, taking initiative, and active participation in decision-making processes helped them define their position within the team more clearly. These experiences not only enhanced their teamwork skills but also strengthened their perceptions of professional roles.

3.1.5. Career Orientation and Transformative Awareness

The final sub-theme under Main Theme 1 relates to how the STP experience contributed to participants' awareness of their career orientation and professional goals. Through the observations and experiences they gained during this process, participants had the opportunity to assess whether the field they were working in suited them. Some discovered that their current field aligned with their interests and clarified their career goals, while others realized that the field did not match their expectations and thus restructured their professional direction. Prominent findings related to this sub-theme were grouped into the following areas: discovery of vocational interest/disinterest, clarification of future plans, and development of self-awareness.

- **Discovery of Vocational Interest/Disinterest**

Participants expressed that the tasks and work areas they engaged with during the STP experience provided them with the opportunity to better understand their vocational interests and inclinations. Some participants realized that the field they were working in aligned well with their personal interests and skills, which led them to develop a stronger motivation toward pursuing that path. Others, on the other hand, discovered that the areas they had previously found appealing were not actually suitable for them once they were exposed to real work settings.

- **Clarification of Future Plans**

Participants indicated that their experiential learning within the STP also influenced their decisions regarding which professional paths to pursue in the future. They noted that playing active roles, directly observing workplace dynamics, and taking on real responsibilities helped them shape their future plans in a more conscious, realistic, and structured manner. As a result of these experiences, they were able to articulate both short-term career steps—such as which internships to pursue or which specialization areas to explore—and long-term goals, such as preferred sectors or interest in entrepreneurship.

- **Development of Self-Awareness**

Participants reported that the experiences they gained throughout the STP process also enhanced their awareness of their personal characteristics. They stated that direct contact with real work environments helped them identify their strengths as well as areas in need of improvement. During this process, they also became more aware of their limitations, expectations, learning styles, and working methods, and noted that this self-awareness enabled them to develop new goals more effectively.

3.2. Main Theme 2: Talent Development Through Mentorship

Main Theme 2—talent development through mentorship—includes four sub-themes: technical and psychosocial guidance from the mentor, the mentor as a role model, trust and openness in the mentorship, and the connection between mentorship and career orientation. This theme draws upon Raelin's [40] theory of work-based learning and Bandura's [14] social learning theory, particularly emphasizing reflection-in-action, modeling, and identity development within relational contexts.

The following table (Table 4) presents the codes derived from all sub-themes under Main Theme 2. Each row includes the related sub-theme, the identified code, representative participant quotes, and the frequency of the code across participants.

Table 4. Thematic Synthesis of Codes under Main Theme 2.

Sub-Themes	Codes	Representative Quotes	Frequency (n = 15)
2.1. Technical and Psychosocial Guidance from the Mentor	(i) Task-Oriented Guidance	P3: "I didn't know the proper sequence for setting up the circuit. But my mentor broke the tasks into parts and explained each one. That allowed me to complete them step by step." P8: "The task I was given at first was very difficult. I didn't know what to do. My mentor showed me step by step, and then I started to gain confidence."	9/15
	(ii) Encouragement to Ask Questions	P5: "In books, I just read and moved on, but here, asking a question and getting a direct answer was completely different. My mentor always said, 'If you don't ask, you can't learn.'" P10: "My mentor always said, 'Say it when you don't understand.' When I asked questions, he never reacted negatively—he just explained. That was really valuable."	10/15
	(iii) Support for Self-Confidence	P6: "My mentor didn't answer questions directly. When he said, 'You decide,' I hesitated at first. But when I saw that the decision I made actually worked, my confidence grew." P8: "At first, I wanted to avoid the task. I kept thinking, 'I can't do this.' But my mentor kept saying, 'You can handle this,' and it really encouraged me. I actually started believing in myself."	9/15
2.2. The Mentor as a Role Model	(i) Observation of Professional Behavior	P3: "There was a problem just hours before the project was due. Everyone was panicking, but our mentor stayed completely calm. That attitude was very instructive for me." P12: "I began to see my mentor not just as an instructor but as someone to look up to. His attitude in meetings and the way he gave feedback taught me a lot."	8/15
	(ii) Behavioral Modeling	P9: "My mentor's eye contact, tone of voice, and the way he asked questions stuck with me. I've started using those same things myself." P11: "My mentor always worked in small steps and would go back when there were errors. Now I code the same way—thinking like he does."	9/15
	(iii) Aspiration to Assume Similar Roles	P2: "When she talked about her career journey, I was deeply inspired. Now I can clearly see what I need to do to become a systems engineer like her." P11: "She had founded her own startup—she was both technical and visionary. I want to be an entrepreneur too. She really inspired me to follow a path like hers."	10/15

Table 4. Cont.

Sub-Themes	Codes	Representative Quotes	Frequency (n = 15)
2.3. Trust and Openness in the Mentoring Relationship	(i) Open Communication	P2: “My mentor was very approachable. I never felt like I had to be overly formal. That made it easier to ask questions and helped me improve myself.” P4: “I made a mistake in the code, but instead of getting upset, my mentor asked why I thought it happened. That helped me become more open about my mistakes.”	10/15
	(ii) Emotional Safety	P3: “I used to want to hide my mistakes, but my mentor’s approach was so supportive. Now I show what I’ve done without fear, because I know I won’t be blamed.” P11: “There were times I completely froze while coding. But when my mentor said, ‘We’ll look at it together, don’t worry,’ I felt so relieved. That kind of support meant a lot.”	9/15
	(iii) Learning without Judgment	P4: “I used to be afraid of admitting mistakes. But here, my mentor treated them as a natural part of the process, and that made learning much easier for me.” P8: “I repeated the same coding error a few times. But instead of scolding me, my mentor said, ‘Take another look—what might you have missed?’ That helped me accept the mistake and work through it.”	9/15
2.4. The Relationship between Mentorship and Career Orientation	(i) Career Guidance	P3: “After my conversations with my mentor, I decided which area I wanted to work in. I was uncertain before, but their guidance really gave me direction.” P11: “My mentor was a technical lead. After talking with her, I realized I wasn’t just interested in coding—I was also interested in team leadership. She helped me see that.”	10/15
	(ii) Raising Awareness	P2: “After a meeting, my mentor said, ‘You communicate well with people—you should make use of that.’ I wasn’t even aware of it.” P5: “My mentor told me, ‘Your technical skills are strong, but you need to work on your analytical thinking.’ That sentence was a turning point for me—I had never questioned that part of myself before.”	9/15
	(iii) Offering Alternative Pathways	P4: “I had always thought of working in corporate companies, but my mentor talked about her startup experience. That sparked my interest in that area too.” P6: “Working abroad had never crossed my mind. My mentor suggested a few programs, and once I looked into them, I got really interested. Now I’m preparing for that path.”	8/15

3.2.1. Technical and Psychosocial Guidance from the Mentor

The first sub-theme under Main Theme 2 highlights that the mentorship practices participants experienced during their time in the STP included both technical and psychosocial dimensions. Participants reported that their mentors not only provided guidance on technical matters but also offered emotional support, facilitated decision-making, and played an encouraging role throughout the learning process. Such mentorship practices helped participants adapt more quickly to work processes and reduced the uncertainty and lack of confidence they experienced at the beginning, enabling more active and self-assured engagement. Participant experiences in this sub-theme were observed across the following dimensions: task-oriented guidance, encouragement to ask questions, and support for self-confidence.

- Task-Oriented Guidance

Participants stated that they initially faced uncertainty regarding task content, prioritization, and process flow when they first joined the STP. However, these uncertainties were significantly reduced through the clear and structured guidance provided by their mentors. They also emphasized that such guidance was not limited to the transfer of technical knowledge but also supported them in managing indecision during application phases.

- Encouragement to Ask Questions

Participants stated that their relationship with their mentors in the STP process not only involved guidance and information sharing but also created a safe learning environment that supported curiosity and active engagement. While many reported feeling passive at the beginning due to fear of making mistakes, feelings of inadequacy, or shyness, they gradually felt more comfortable asking questions thanks to the encouraging attitude of their mentors. Participants particularly emphasized that this supportive approach contributed not only to their cognitive development but also significantly boosted their self-confidence.

- Support for Self-Confidence

Participants expressed that, due to the tasks, uncertainties, and responsibilities they encountered for the first time during their STP experience, they occasionally felt a sense of inadequacy. In such moments, they stated that the encouraging and supportive attitudes of their mentors strengthened their belief in their own capabilities, significantly contributing to the development of their self-confidence.

3.2.2. The Mentor as a Role Model

Another prominent sub-theme under Main Theme 2 is that participants perceived their mentors as role models in terms of attitude, behavior, and professional conduct. Participants stated that the mentorship enabled them to move beyond an abstract perspective of their profession and engage with tangible behavioral patterns and professional identity models. Observing their mentors' decision-making styles, responses during crises, and roles within the team, participants reported that they sought to incorporate these behavioral patterns into their own developmental processes. Findings related to this theme were shaped around the following focal points: observation of professional behavior, behavioral modeling, and aspiration to assume similar roles.

- Observation of Professional Behavior

Participants noted that during their STP experience, their mentors contributed not only through the transmission of technical knowledge but also by exemplifying professional conduct. They especially emphasized closely observing their mentors' behaviors during meetings, their responses in high-pressure situations, their style of delivering feedback,

and their communication within the team. These observations served as concrete examples for participants in shaping their own professional behavior.

- Behavioral Modeling

Participants reported that throughout the mentorship process, they consciously or intuitively imitated their mentors' attitudes and behaviors. They indicated that this was evident across multiple dimensions, including communication style, methods of coping with stress, leadership approach, and team relationship management. Some participants noted that over time, they found themselves reacting or making decisions in ways similar to their mentors.

- Aspiration to Assume Similar Roles

Some participants expressed that they identified with their mentors' professional identities. This identification transformed the mentor from someone who simply shared knowledge and experience into a role model who represented an aspirational "future self". Participants shared that the role their mentor held inspired in them a desire to pursue a similar position. Some students stated that they envisioned themselves as future experts, leaders, or academics, and that this vision became a key factor in clarifying their career orientation and fueling their internal motivation.

3.2.3. Trust and Openness in the Mentorship

Another significant sub-theme that emerged under Main Theme 2 is the deepening effect of trust within mentorship on the learning process. Participants emphasized that a trust-based relationship with their mentors enabled them to ask more questions, engage actively without fear of making mistakes, and become more receptive to feedback. This atmosphere of trust fostered a learning environment not only at the cognitive level but also at the emotional level, making the overall learning process more effective. These findings are associated with the following thematic codes: open communication, emotional safety, and nonjudgmental learning.

- Open Communication

Participants emphasized that during their mentorship experiences in the STP, the direct, sincere, and open communication they had with their mentors positively impacted their learning processes. This communication style not only facilitated the flow of information but also helped participants feel more comfortable expressing themselves. Some participants mentioned that open communication helped prevent misunderstandings and made the process of receiving feedback more natural and constructive.

- Emotional Safety

Participants shared that they established a sense of emotional safety during the mentorship process. Especially at the beginning of the experience, they noted that their initial anxiety, uncertainty, and fear of making mistakes significantly decreased due to the supportive and understanding attitudes of their mentors. This emotional safety allowed them to engage more freely, comfortably, and willingly in the process. They also highlighted that emotional security enhanced emotional expression, personal growth, and freedom of speech, ultimately reinforcing the holistic nature of learning.

- Learning without Judgment

Participants emphasized that one of the most crucial elements supporting their learning during the STP experience was feeling accepted by their mentors without judgment and having the right to make mistakes. This sense of trust allowed them to share their mistakes openly rather than conceal them, which in turn enabled a more honest and authentic

learning process. They also highlighted that their mentors' understanding and inclusive attitudes not only facilitated technical learning but also supported their self-awareness and positively influenced their confidence.

3.2.4. Connection Between Mentorship and Career Orientation

The final sub-theme under Main Theme 2 concerns the significant influence of mentorship on students' career orientation. Participants stated that their mentors' professional backgrounds, experiences, and guidance helped them better recognize their interests and formulate more structured career goals. Some participants indicated that the mentorship practices helped clarify previously uncertain aspects of their professional aspirations and allowed them to develop a stronger sense of direction in their career planning. The findings in this context are represented in the following code clusters: career guidance, raising awareness, and offering alternative pathways.

- Career Guidance

Participants stated that their mentorship experiences in the STP played a guiding role in important career-related decision-making processes. They explained that mentors' sharing of their professional backgrounds, offering of sectoral insights, and support in recognizing personal strengths helped them shape their career decisions in a more informed and goal-oriented manner. During this process, mentors provided significant guidance in evaluating career options, comparing alternatives, and clarifying individual directions.

- Raising Awareness

Participants shared that the mentorship process contributed to developing a deeper awareness of their competence levels, areas of interest, and potential. They stated that their mentors' guidance helped them identify their strengths, more clearly see areas for improvement, and connect their personal values with professional preferences. Participants emphasized that this process sparked an internal inquiry not only into what they wanted to do but also into why and how they wanted to pursue it.

- Offering Alternative Pathways

Participants stated that their mentors contributed to broadening their career perspectives during the mentorship process. Some explained that their mentors did not confine them to conventional trajectories but instead introduced them to new possibilities regarding alternative professions, career stages, and development opportunities. In this regard, the mentorship experience was described not merely as a guidance relationship but as a learning environment that expanded participants' career options and enhanced their vision for the future.

4. Discussion

This study aimed to explore how university students' experiential learning and mentorship experiences within the context of an STPs influence their individual and professional development. Guided by a phenomenological methodology, the research focused on how students make sense of theoretical knowledge in practice-based environments and how mentorship shapes their career awareness and professional identity. The discussion that follows addresses two core dimensions—experiential learning and mentorship—and interprets the findings through the lens of established learning theories and in comparison with prior research. In doing so, it seeks to answer the following research questions: (1) How do experiential learning processes in STPs contribute to student development? (2) How does mentorship facilitate professional identity formation and career direction?

4.1. *Experiential Learning as a Driver of Transformative Talent Development*

Findings related to the sub-theme “Transfer of Theoretical Knowledge into Practice” indicate that students engaged in application-based learning by integrating their theoretical knowledge into real work processes within the STP context. Having the opportunity to apply theory in practice enabled students to transform the learning process from one based solely on knowledge acquisition into a more contextual and experience-driven structure. This finding directly aligns with Kolb’s [15] experiential learning cycle, particularly the stages of “concrete experience” and “active experimentation”. As students used abstract concepts in real tasks, they reported not only memorizing information but also grasping its contextual function. This suggests that learning is a process that integrates cognition with action and outcome. The existing literature on work-based learning also highlights that learning is deepened through practice and that experiential engagement enhances the retention of learning outcomes [39,40]. In this regard, STPs offer students opportunities to encounter, test, and restructure theoretical knowledge within authentic production environments—turning learning into a transformative experience. However, it is important to acknowledge that the effectiveness of theory-to-practice transfer may vary depending on contextual factors such as task complexity, quality of mentorship, and the student’s prior work exposure. In cases where these enabling conditions are weak, experiential learning may remain superficial despite being hands-on [68].

Findings related to the second sub-theme, “Deepening of Learning through Experience”, reveal that students approached learning in a more critical, awareness-driven, and multidimensional manner when confronted with uncertainty, problem-solving requirements, and flexible conditions within the STP environment. When faced with unpredictable situations, students adopted a reconstructive attitude toward knowledge. In this context, the learning process required not only the use of existing knowledge but also the questioning of underlying assumptions and the generation of alternative solutions. This aligns directly with Mezirow’s [69] theory of transformative learning, particularly the concepts of “critical reflection” and “reconstruction of meaning structures”. Furthermore, the students’ development of flexible thinking and their ability to revise their own learning strategies contributed to an increase in metacognitive awareness and promoted more self-directed learning behaviors. These findings suggest that in complex and dynamic work environments, learning is not a linear process but rather an adaptive and reflexive one. Recent case studies conducted in post-pandemic learning environments have highlighted the growing significance of experiential learning ecosystems in preparing students for uncertainty and complexity in the workforce [38]. In particular, recent studies on hybrid STP models confirm their effectiveness in preparing students for uncertainty through multimodal and team-based learning structures [20]. These findings align with this study’s results regarding the role of STPs in fostering adaptable, self-directed learners.

Nonetheless, recent studies emphasize that without structured reflection mechanisms or guided facilitation, students may struggle to derive deeper meaning from their experiential learning—especially in fast-paced or loosely organized settings. For instance, Mahapoonyanont [70] found that the absence of reflective scaffolding in higher education limited students’ ability to internalize learning outcomes. Similarly, Stirling et al. [71] argue that unstructured work-integrated learning environments often fail to support metacognitive development unless supported by deliberate mentoring and reflective components.

Additionally, findings from the sub-theme “Concretization and Retention of Learning” indicate that students did not perceive learning as merely a cognitive acquisition, but as a multilayered process involving emotional connection, meaning-making, and practical contribution. The roles students assumed, the tangible outputs they produced, and the responsibilities they undertook during tasks contributed to deeper encoding of knowledge

in long-term memory. Emotional engagement with knowledge, integration with the task, and visible contribution to outcomes transformed learning into more than just a memorable event—it became a meaning-making process linked to the learner’s sense of self. This aligns with Van Manen’s [57] phenomenological notion of the “essence of lived experience”, where learning is not solely about what is learned, but also about how and why it is learned. Moreover, the findings illustrate that learning is enriched not only cognitively but also emotionally and socially; and that long-term retention is supported not merely by repetition, but by experience integrated with emotion and personal significance. These insights are further supported by Eraut’s [39] model of work-based learning and Raelin’s [40] theory of reflective practice.

The next sub-theme, “Professional Identity and Role Awareness”, highlights how students’ roles and responsibilities during their STP experiences contributed to the consolidation of their occupational self-perception and supported the development of their professional identity. Participants reported that their visibility within the team and their direct contributions to project outcomes made them feel like real employees. This aligns with the concept of identity formation through group affiliation as outlined in Ashforth and Mael’s [72] social identity theory. The concreteness of students’ professional self-perceptions enabled them to more clearly define their roles and deepen their awareness of these roles. Similarly, in their study on nursing students, Gregg and Magilvy [73] emphasized that clinical practice supported the development of professional identity by facilitating the recognition of occupational values and the integration of personal identity with professional roles. In this context, STPs provide an important learning environment for shaping professional identity and enhancing role awareness among students.

The final sub-theme, “Career Orientation and Transformative Awareness”, reflects how students, through their experiences in STPs, questioned and reassessed their vocational inclinations and acted more consciously and reflectively in identifying career paths that aligned with their personal attributes. Participants not only developed clarity on which fields they were drawn to but also gained insight into areas that did not align with their expectations—leading to meaningful career awareness. This finding is directly associated with the concept of “vocational self-concept” as defined in Super’s [74] life-span, life-space theory of career development. Through these experiences, students were able to form stronger connections between their professional identities and their personal values and interests. Likewise, Savickas’s [6] career construction theory, which emphasizes the dimensions of awareness, preparedness, and adaptability, suggests that students undergo an internal process of direction-finding as part of their career development. Similarly, Hall [75] stresses in his work that decision-making grounded in self-awareness not only shapes job selection but also significantly influences long-term career satisfaction. In this regard, the experiences gained in STPs are shown to provide strategic learning spaces that nurture not only technical skills but also psychological processes such as personal insight, direction-finding, and meaningful career decision-making.

The experiential learning-related sub-themes identified in this study are closely aligned with the targets of SDG 4 and SDG 8 (see Table 5). Specifically, “Transfer of Theoretical Knowledge into Practice” supports SDG 4.4, which promotes the development of relevant skills for employability and entrepreneurship. “Deepening of Learning through Experience” and “Concretization and Retention of Learning” reflect SDG 4.7, which emphasizes the importance of experiential, inclusive, and reflective learning approaches. Furthermore, the development of “Professional Identity” and “Career Orientation” speaks directly to SDG 8.6 and 8.b by equipping young individuals with the clarity, confidence, and competencies required to enter the labor market and make informed career decisions. These findings

indicate that STP-based experiential learning is not only a pedagogical tool but also a vehicle for achieving long-term educational and economic sustainability goals.

Table 5. Mapping of Experiential Learning Sub-Themes to Relevant SDGs.

Sub-Themes	Relevant SDGs
Transfer of Theoretical Knowledge into Practice	SDG 4.4—Technical and vocational skills
Deepening of Learning through Experience	SDG 4.7—Experiential and reflective learning
Concretization and Retention of Learning	SDG 4.1—Effective learning outcomes
Professional Identity and Role Awareness	SDG 4.7—Meaningful, learner-centered education
Career Orientation and Transformative Awareness	SDG 8.6—Youth not in education, employment or training (NEET)
	SDG 8.b—Youth employment strategies

4.2. Strategic Mentorship as a Catalyst for Professional Identity and Career Navigation

Findings related to the first sub-theme—“The Mentor’s Technical and Psychosocial Guidance”—reveal that mentors played both directive and emotionally supportive roles in helping students adapt to the STP environment and structure their learning processes. Participants stated that their mentors’ technical guidance in areas such as task distribution, priority setting, and time management reduced initial uncertainty and facilitated a smoother integration into the work environment. This structured support contributed to the development of students’ ability to take responsibility and helped transform them into more active learners. At the same time, the mentors’ encouraging and nonjudgmental attitudes enabled students to overcome fears related to asking questions, receiving feedback, and making mistakes. This process aligns with Rogers’ [69] emphasis on psychological safety in learning environments. Within Kram’s [16] mentorship model, the dimensions of task-related guidance and psychosocial support illustrate how such interventions contribute both to technical competence and the development of self-confidence. Similarly, studies by Allen et al. [42] have shown that mentorship positively affects mentees’ task performance and emotional commitment. In this context, mentorship established within the STP can be regarded as multifaceted support systems that not only facilitate knowledge transfer but also provide psychologically safe social spaces that make learning possible.

Findings related to the second sub-theme, “The Mentor as a Role Model”, demonstrate that students did not experience the mentorship solely as a knowledge acquisition process but also as a form of social learning where professional behaviors were observed and internalized. Participants reported that they closely observed their mentors’ communication styles, crisis management approaches, roles within the team, and methods of delivering feedback, and shaped their own professional behavior patterns through these observations. Through this process, students did not only gain technical skills but also learned how to answer the question, “What does it mean to be a professional?” by watching their mentors in action. This form of learning can be explained through Bandura’s [14] social learning theory, particularly the principle of modeling, wherein both the cognitive and emotional behaviors of the mentor are taken as examples by the student. Mentors, in this regard, became more than sources of information—they were figures who modeled values, attitudes, and professional identity. This observation aligns with Allen et al. [42], who emphasize that in effective mentorship, the mentor’s approach plays a key role in shaping the mentee’s career path and transmitting professional values. Additionally, the findings show that some students identified with their mentors and developed aspirations to assume similar roles in the future. This indicates that mentorship not only generates learning outcomes but also serves as a critical source for constructing students’ ideal selves and long-term professional visions. However, the internalization of mentor behaviors is not always straightforward. If the mentor’s conduct is inconsistent or misaligned with

organizational values, it may lead to confusion or unintended modeling outcomes for the student [55].

Next, findings related to the sub-theme, “Trust and Openness in the Mentorship”, show that mentorship interactions fostered a sense of psychological safety, which was a decisive factor in participants’ engagement with the learning process. Participants reported that the open and nonjudgmental communication they established with their mentors helped reduce the initial hesitation and fear of making mistakes, particularly during the early stages of their experience. As a result of this trust-based relationship, students were more willing to ask questions, share ideas, and learn from their mistakes without fear. This finding directly aligns with Rogers’ [76] principles of “unconditional positive regard” and “psychological safety” in learning environments. According to Rogers, effective learning can only occur when individuals feel free to express themselves without fear of judgment—a condition that, as the findings reveal, was established in the STP through mentorship. Moreover, Bandura’s [14] self-efficacy theory highlights the importance of emotional states in influencing learning outcomes; in this case, students developed positive beliefs about their learning capacities as a result of supportive mentor behaviors. Similarly, a meta-analysis by Eby et al. [55] underscores that the quality of the mentorship significantly influences mentees’ learning motivation and confidence levels. In line with this, recent institutional studies confirm that digital mentorship frameworks implemented in post-pandemic STP environments improve both career adaptability and emotional security among mentees [50]. In this regard, trust-based mentorship formed within the STP environment functions not only as cognitive learning spaces but also as holistic learning environments that support emotional and social development.

The final sub-theme, “The Relationship between Mentorship and Career Orientation”, reveals that mentors acted not only as sources of knowledge but also as strategic agents who raised awareness, provided direction, and revealed alternative career paths. Participants reported that their mentorship helped them more clearly identify both the fields they were interested in and those they were not. Additionally, through mentors’ sharing of personal experiences, professional insights, and targeted suggestions, students were able to develop more informed and structured career plans. This process is in line with Super’s [74] lifespan, life-space theory of career development, particularly the concepts of “vocational self-concept” and “experience-based direction-finding”. The development of students’ ability to chart a vocational route aligned with their skills and values emerged in this study as a mechanism strengthened through mentor support. Furthermore, the dimensions of “readiness” and “adaptability” emphasized in Savickas’s [6] career construction theory are also supported by these findings. Mentors did not merely provide information about existing career paths—they helped students become aware of opportunities they had not previously considered, thereby expanding the scope of their career decision-making. These results echo the findings of Allen and Eby [46], who identified effective mentorship as among the most influential social resources guiding career development. Ultimately, in this context, mentorship emerges not only as a process that reinforces existing trajectories but also as a strategic learning experience that opens new directions for professional growth. Still, the quality and outcomes of mentorship can vary significantly depending on relational dynamics, mentor expertise, and interaction frequency. Not all students may benefit equally, especially in cases where the mentor–mentee match lacks alignment in expectations or communication style [77,78].

The mentorship-related outcomes observed in this study are also consistent with findings from other developing regions. In Eastern Europe, Ćudić et al. [19] highlighted that mentorship in STPs contributed significantly to students’ career adaptability and direction-finding, particularly in resource-constrained innovation ecosystems. Similarly,

Nabi et al. [79], in a recent systematic review, emphasized that emotionally supportive mentors play a pivotal role in facilitating students' career planning and transition processes within higher education contexts. Their work distinguishes between career-related and psychosocial mentoring functions, underscoring that both are essential for meaningful developmental outcomes. Moreover, they underline the universality of mentorship as both a cognitive and affective support mechanism, especially in transition economies where institutional guidance is limited but social capital plays a compensatory role.

The mentorship-related findings of this study can also be mapped directly onto several sub-targets within the SDGs framework (see Table 6). “Technical and Psychosocial Guidance” and “Trust and Openness in the Mentoring Relationship” exemplify the conditions emphasized in SDG 4.7 and SDG 4.a, promoting emotionally secure and inclusive learning environments. “The Mentor as a Role Model” aligns with SDG 4.5, supporting the reduction in educational and professional inequalities through guidance and behavioral modeling. Finally, “Mentorship and Career Orientation” contributes to SDG 8.6 and 8.b by enhancing young people's capacity for career planning, increasing their employability, and informing youth-oriented labor market strategies. These results highlight mentorship as a critical mechanism for embedding sustainable, human-centered development strategies into higher education systems through STP contexts.

Table 6. Mapping of Mentorship-Related Sub-Themes to Relevant SDGs.

Sub-Themes	Relevant SDGs
Technical and Psychosocial Guidance from the Mentor	SDG 4.7—Supportive, inclusive learning approaches
The Mentor as a Role Model	SDG 4.5—Equal opportunities through mentorship
Trust and Openness in the Mentorship	SDG 4.a—Safe, nonjudgmental learning environments
Relationship between Mentorship and Career Orientation	SDG 8.6—Career planning for youth
	SDG 8.b—Youth-oriented labor market

5. Conclusions

This study demonstrates that experiences gained in STPs generate outcomes that are directly linked to the strategic human capital development functions of higher education institutions. The transformation of theoretical knowledge into applied competence, the development of professional identity, and the enhancement of career awareness illustrate that experiential learning and mentorship operate as an integrated developmental structure. These findings align with the literature emphasizing the transformative power of real-world learning contexts [15,39] and support recent empirical evidence on the positive effects of work-based mentorship on students' career orientation [55]. Moreover, the study echoes earlier work suggesting that identity formation and reflective learning are best cultivated in authentic, high-stakes environments [57,72]. This observation is further supported by recent comparative case studies highlighting the replicability of mentorship-integrated learning ecosystems in STPs across Latin America and Eastern Europe [18,19].

In terms of institutional implications, the study provides practical guidance for higher education institutions. Project-based applications and mentorship programs implemented within STPs can be systematically integrated with university career centers, curriculum design processes, and alumni tracking systems to form sustainable talent development models. Such integrated structures not only enhance students' employability but also increase alignment with institutional graduate profile targets [6]. Mentorship systems should not be left to informal or voluntary initiatives but rather supported through defined institutional roles, structured matching algorithms, and monitoring and evaluation mechanisms [16]. Similarly, national STP policies should be restructured not only around R&D and technological outputs but also with a strategic focus on building a qualified and sus-

tainable workforce. To maximize impact, it is recommended that university administrators and policy-makers institutionalize STP-based experiential learning through formal policy instruments—such as elective course modules, credit-based internship systems, mentorship certification programs, and long-term partnerships between faculties and STPs.

Regarding transferability and broader relevance, although this study was conducted within a single STP in Türkiye, its findings may hold broader relevance for other higher education institutions operating in similar science and technology park ecosystems. Key success factors—such as programmatic alignment, mentor quality, and reflective learning design—can inform the replication or adaptation of such initiatives in diverse institutional and cultural settings. Furthermore, these models can be tailored to regional innovation needs, supporting policy-level efforts to embed experiential learning within human capital development strategies. Future research is encouraged to explore how these mechanisms function across varying geographies and governance models.

Taking all these into consideration, experiences gained in STPs should be viewed not only as contributions to individual development but also as structural mechanisms that directly support the transformation of higher education systems in terms of institutional capacity, employment strategies, and national-level human capital planning. In this respect, this study's findings indicate that higher education institutions need to develop experiential learning systems that are integrated with sustainable human capital strategies. As such, this study offers a strategic framework that contributes to SDG 4 by promoting inclusive, flexible, and lifelong learning models, while also supporting SDG 8 by enhancing young talents' employability and career orientation capacities.

These insights, while illuminating, are bounded by contextual and methodological limitations, which are discussed in the next section along with suggestions for future research trajectories.

5.1. Limitations of This Study

This study was structured based on a qualitative and phenomenological approach, and the findings were derived from a specific sample within a particular context. In this regard, this study has several limitations. First, the research data are based solely on in-depth interviews conducted with 15 university students within a single STP. While the sample size is adequate for qualitative research, the generalizability of the findings is inherently limited.

Second, participants differed in their academic disciplines, duration of involvement, and intensity of experience. Although this diversity enriched the analysis, it may have also constrained the depth of certain thematic findings due to variations in the level of experience among participants. Furthermore, the majority of the interviews were conducted in online settings, which may have limited some participants' ability to express emotional nuances or fully convey interactive dynamics.

Moreover, this study was conducted exclusively from the student perspective; the viewpoints of STP administrators, mentors, or institutional professionals were not included in the analysis. As a result, mentorship and experiential learning environments were evaluated solely based on mentees' experiences.

Last, while this study is based on a single STP in İstanbul, the purposive sampling strategy and phenomenological depth aim not at generalizability but at transferability—providing readers with sufficient contextual detail to judge the relevance of findings to their own settings. In qualitative research, transferability refers to the extent to which findings resonate across settings with similar contextual features, as assessed by the reader. Unlike generalizability, which assumes statistical representativeness, transferability is enabled through thick description and contextual transparency [63,80]. İstanbul's unique

status as a metropolitan innovation hub may have shaped students' exposure to diverse mentorship and experiential opportunities. However, the core developmental processes identified—such as identity formation, reflective learning, and career clarity—are not exclusive to this location and may be applicable to STP contexts that share structural and pedagogical characteristics. This study was therefore designed to enable readers to make informed judgments about its applicability to their own institutional realities, offering analytically transferable insights for higher education institutions operating in similarly complex university–industry ecosystems.

5.2. Directions for Future Studies

While this study offers in-depth insights into undergraduate students' experiential learning and mentorship experiences within an STP setting, several directions remain for future research. First, future studies could adopt a multistakeholder approach by including the perspectives of mentors, technology and science park administrators, and industry partners. Integrating these viewpoints would provide a more holistic understanding of the structural and relational dynamics that shape talent development in university–industry interfaces.

Second, longitudinal research designs could be employed to assess the long-term impact of science park experiences on graduates' career trajectories, employability, and sustained professional growth. Tracking participants over time would offer stronger causal inferences about the developmental value of experiential learning in institutional settings.

Third, comparative research across different national contexts or institutional models of science parks could reveal how varying levels of infrastructural support, mentorship structuring, or university–industry collaboration influence learning outcomes. This would also support the development of internationally adaptable models for sustainable talent development in higher education.

Next, future studies could explore the following: “What are the long-term effects of STP-based mentorship on the development of sustainability competencies among graduate students, and how do these effects vary across regional or cultural contexts?” Such inquiry would help to develop comparative frameworks that account for contextual diversity in sustainability-oriented talent development models within higher education systems.

Finally, future research may explore the role of technology and science parks in advancing digital, entrepreneurial, and sustainability-related competencies, especially in light of global shifts in labor market demands and higher education reforms. Such inquiries would extend the strategic relevance of science parks within the framework of SDGs, particularly SDG 4 and SDG 8.

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Data Availability Statement: The qualitative data used in this study consist of in-depth interview transcripts that contain highly contextual, profession-specific narratives and potentially identifiable

information, even after de-identification. Due to the sensitive nature of the content and the risk of deductive disclosure, public sharing of the full dataset is not ethically permissible. However, interested researchers may request access to a limited set of anonymized excerpts for the purpose of verifying findings or methodological transparency. Such requests will be evaluated on a case-by-case basis by the Ethics Committee of Beykoz University, to ensure compliance with ethical and legal standards. Requests may be directed to: yarenpakizekececi@beykoz.edu.tr.

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Abbreviations

The following abbreviations are used in this manuscript:

R&D Research and Development
STPs Science and Technology Park(s)

Appendix A. Semi-Structured Interview Guide

1. What types of experiential learning activities did you participate in during your time at the STP?
2. In what ways do you think these experiences contributed to your learning?
3. Did you have the opportunity to work one-on-one with a mentor?
4. If so, what were the contributions of the mentorship relationship to your development?
5. How would you describe the nature of your communication with your mentor?
6. How frequently and in what ways did you interact with professionals at the STP?
7. Were you able to observe the workplace culture? What kind of impression did it leave on you?
8. Do you believe you experienced any development in your professional competencies during this process?
9. How would you describe your professional self—has this changed before and after the experience?
10. What was the most significant challenge you encountered?
11. In your opinion, how can such experiences be made more effective?
12. Was there any aspect you felt was lacking during this process?

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