



Computational Thinking and Career Identity Among Electrical Engineering Students

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relevant to electrical engineering education.

Abstract: *In the digital transformation era, computational thinking is vital in engineering education, yet its integrated role in shaping electrical engineering students' career identity remains underexplored. This study aims to analyse the conceptual relationship between computational thinking and the career identity of electrical engineering students within the context of engineering higher education. The study employed a structured narrative review of 31 reputable international journal articles indexed in Scopus and Web of Science, published between 2022-2026. The analysis was conducted thematically through data reduction, open coding, theme categorisation, and narrative synthesis to identify patterns of relationship among computational thinking, career identity, and psychosocial linking factors. The findings indicate that computational thinking should not be positioned merely as a learning outcome, but rather as an epistemic-professional resource that has the potential to strengthen the career identity of electrical engineering students. This relationship does not occur directly; instead, it is mediated by self-concept, sense of belonging, and career aspirations. This review proposes a conceptual model in which engineering learning experiences foster the development of computational thinking, which subsequently strengthens students' perceptions of competence and academic meaningfulness, thereby contributing to the formation of career identity. These findings extend the existing literature by integrating computational thinking, engineering identity, and psychosocial factors into a unified framework that is*

Keywords: *Computational Thinking, Career Identity, Engineering Identity, Electrical Engineering, Sense of Belonging, Self-Concept*

Introduction

The development of engineering higher education in the era of digital transformation requires universities not only to produce graduates who master conceptual knowledge, but also to cultivate ways of thinking that are adaptive, structured, and relevant to professional demands. In this context, computational thinking is increasingly regarded as an important competency, as it enables students to understand complex problems through decomposition, abstraction, pattern recognition, and the systematic formulation of solution steps. Wang et al. (2022) explain that computational thinking has developed into one of the central constructs in STEM education because of its potential to strengthen cross-disciplinary thinking processes. Lu et al. (2022) further demonstrate that, in higher education, studies on computational thinking are no longer limited to programming but have expanded toward thinking competencies that support the resolution of academic and professional problems.

The position of computational thinking becomes even more relevant in the field of electrical engineering, as the disciplinary characteristics of this field require students to work with systems, symbols, models, algorithms, and problem solving based on technical representations. Electrical engineering students engage in activities such as circuit analysis, control system modelling, hardware–software integration, and troubleshooting, all of which require sequential and structured reasoning. Osztián et al. (2022) show that computational thinking among early-stage computer science and engineering students is closely related to diagrammatic reasoning and the ability to interpret problem representations. This finding reinforces the view that computational thinking in engineering education functions not merely as a computational skill, but also as a reasoning framework that supports the quality of students' intellectual work in technical contexts.

To date, attention to computational thinking in engineering education has tended to focus on learning outcomes, assessment instruments, or the effectiveness of instructional interventions. Wang et al. (2022) map out that most studies examine how computational thinking is integrated into STEM learning and how this competency is measured in educational settings. Lu et al. (2022) also emphasise that studies at the higher education level remain dominated by discussions of programming instruction, instructional strategies, and students' cognitive achievement. This tendency indicates that computational thinking is more often positioned as a learning outcome than as part of students' self-formation within their professional pathways. In engineering education, however, students' ways of thinking may significantly influence how they evaluate their fit with the field they are studying.

The issue of how students perceive themselves within the field of engineering becomes important when linked to the concept of career identity. In engineering higher education, career identity does not merely refer to the desire to work in a particular field, but also to students' self-perceptions as individuals who possess interest, recognition, competence, and commitment toward the engineering profession. Ju & Zhu (2023) show that practice-oriented learning experiences contribute positively to the strengthening of engineering identity among final-year students. Lockhart & Rambo-Hernandez (2024) affirm that engineering identity is dynamic and begins to develop from the early years of study; therefore, its formation cannot be separated from students' academic experiences.

More recent studies also indicate that engineering identity has developed into a construct that is increasingly robust both conceptually and psychometrically. Lockhart et al. (2025) provide validity evidence for an engineering identity scale, highlighting the importance of recognition, competence, and students' attachment to the field of engineering. Jiang et al. (2025) through a meta-analysis, show that STEM identity is positively associated with career intentions, suggesting that identity is not only a psychological consequence of the learning process but also a predictor of students' professional orientation. These findings indicate that engineering education should be understood not only as a process of knowledge transmission, but also as an arena for the formation of academic and career identity.

Psychosocial factors appear to play an important role in the formation of such identity. Dost (2024) shows that sense of belonging in STEM is understood by students as the experience of feeling accepted, valued, and part of a learning community. Hansen et al.

(2024) demonstrate that belonging in STEM environments is associated with students' continued participation, particularly among vulnerable groups. Chen et al. (2024) further add that STEM learning opportunities and perceptions of STEM professionals are related to students' career aspirations through the role of self-concept. These findings suggest that the career identity of engineering students is shaped by the interaction between learning experiences, self-perception, and the socio-academic context.

Nevertheless, the literature still reveals a disconnect between studies on computational thinking and those on career identity. Research on computational thinking tends to stop at issues of teaching, assessment, or students' cognitive performance, whereas studies on career identity more frequently emphasise practical experiences, sense of belonging, and students' future orientations. Wang et al. (2022) and Lu et al. (2022) have not explicitly positioned computational thinking as a factor related to career identity, while Ju & Zhu (2023), Lockhart & Rambo-Hernandez (2024), and Jiang et al. (2025) do not place computational thinking as a key variable in the formation of engineering identity. This gap indicates that the relationship between computational thinking ability and the career identity of engineering students has not yet been sufficiently discussed in an integrated manner.

This gap becomes particularly significant in the context of electrical engineering students. Compared with STEM students in general, electrical engineering students encounter disciplinary characteristics that strongly demand systemic reasoning, technical modelling, and structured problem solving. These characteristics suggest that computational thinking may have a more direct meaning for the formation of students' perceived competence and professional direction. At the same time, the career identity of electrical engineering students is also likely to be influenced by practical experiences, troubleshooting activities, laboratory work, and exposure to the specific nature of the engineering profession. Therefore, a study that brings together computational thinking and career identity in the context of electrical engineering students has both theoretical and practical relevance.

Based on the above discussion, this article examines the conceptual relationship between computational thinking and the career identity of electrical engineering students through a structured narrative review. This review is important for developing a more comprehensive understanding of how thinking competencies, learning experiences, and psychosocial factors contribute to the formation of students' professional identity in engineering. The novelty of this study lies in bridging the previously separate literatures on computational thinking and career identity/engineering identity within the context of electrical engineering education. This study advances existing scholarship by positioning computational thinking not merely as a cognitive learning outcome or instructional competency, but as an epistemic-professional resource that may support the formation of students' career identity through perceived competence, self-concept, sense of belonging, and career aspirations. Practically, this novel framework provides a conceptual foundation for developing instructional practices, strengthening academic experiences, and enhancing career guidance aimed at fostering students' technical competence, psychosocial development, and professional orientation in engineering higher education.

Methodology

This study employed a structured narrative review approach to purposively synthesise the literature on computational thinking and the career identity of electrical engineering students. This approach was selected because it enables a systematic, structured, and interpretative conceptual reading without requiring a quantitative synthesis such as meta-analysis. Snyder (2019) explains that a literature review can be used to map concepts, clarify relationships among constructs, and develop a research agenda when a field of inquiry remains dispersed across several bodies of literature. Grant & Booth (2009) also emphasise that a narrative review is relevant when the aim is to integrate theoretically and methodologically diverse findings in order to generate a more comprehensive conceptual understanding. Based on these principles, the literature search was conducted in April 2026 using the Scopus and Web of Science databases. The final corpus consisted of 31 international journal articles published between 2022 and 2026 by SpringerLink, Frontiers, and Taylor & Francis/Tandfonline.

The search process used the following main keywords: computational thinking, engineering identity, career identity, electrical engineering students, STEM identity, sense of belonging, self-concept, and career aspiration. All article metadata were managed using Zotero for citation collection, bibliographic standardisation, and duplicate removal. The data were then transferred to Microsoft Excel to develop a review matrix containing article identification, research objectives, methods, participants, key constructs, and main findings. The inclusion criteria comprised English-language journal articles indexed in Scopus or Web of Science, published between 2022 and 2026, issued by the three predetermined publishers, and relevant to at least one of the three synthesis domains: computational thinking, career identity/engineering identity, and linking factors such as sense of belonging or career aspirations. Articles were excluded if they were conference proceedings, editorials, book chapters, non-journal publications, published outside the specified period, or not substantively related to engineering/STEM students. The analysis was conducted thematically through data reduction, open coding, theme clustering, and narrative synthesis to identify patterns of relationship among computational thinking, career identity, and linking factors in the context of electrical engineering students. This procedure is consistent with guidelines for thematic synthesis in review-based research, which emphasise the systematic identification of patterns of meaning across studies (Thomas & Harden, 2008), as well as with the principles of reflexive thematic analysis, which position themes as interpretative outputs developed progressively from textual data (Braun & Clarke, 2022).

Result and Discussion

Corpus Characteristics and Distribution of Studies

The final corpus of this review consisted of 31 reputable international journal articles published between 2022 and 2026. The distribution of articles revealed three main domains: computational thinking (CT), career identity/engineering identity, and linking factors such as sense of belonging, self-concept, and career aspirations. As shown in Table 1, the CT domain constituted the largest body of literature, comprising 12 articles (38.7%), followed by linking factors with 11 articles (35.5%) and career identity/engineering identity with 8 articles (25.8%). This composition indicates that the literature has developed more

extensively in positioning CT as a pedagogical and cognitive construct than as a factor directly associated with the formation of students’ professional identity. This tendency is consistent with literature mappings of CT that highlight its role in learning integration, assessment, and the development of structured thinking skills in STEM and higher education contexts (Belmar, 2022; Lu et al., 2022; Wang et al., 2022).

Table 1: Distribution of the Corpus by Research Domain

Review domain	Number of articles	Percentage	Representative articles
Computational thinking	12	38.7%	Wang et al. (2022); Lu et al. (2022); Zhang et al. (2024)
Career identity / engineering identity	8	25.8%	Ju & Zhu (2023); Lockhart & Rambo-Hernandez (2024); Jiang et al. (2025)
Bridging factors	11	35.5%	Aguirre Munoz et al. (2025); Chen et al. (2024); Hansen et al. (2024)

From a methodological perspective, the corpus shows a dominance of empirical quantitative approaches, including surveys, structural equation modelling, latent profile analysis, instrument development, and quasi-experimental learning studies. As summarised in Table 2, this group comprised 16 articles (51.6%). The second group consisted of review-based articles, including scoping reviews, systematic reviews, integrative reviews, and meta-analyses, with 11 articles (35.5%). Meanwhile, qualitative, mixed-methods, and reflective studies accounted for only 4 articles (12.9%). This pattern indicates that the field has become relatively well established in mapping trends, measuring constructs, and testing relationships among components. However, it remains comparatively limited in providing in-depth explanations of how students experience the formation of professional identity through their academic and cognitive experiences. This finding appears consistent with the studies by Aguirre Munoz et al. (2025), Kang et al. (2023), Lockhart et al. (2025), Passeggia et al. (2026) on the one hand, and those by Chan et al. (2025), Earle et al. (2024), Young et al. (2024) on the other.

Table 2: Distribution of Articles by Methodological Approach

Methodological approach	Number of articles	Percentage	General characteristics
Quantitative empirical / quasi-experimental / instrument development	16	51.6%	Dominant in CT, identity, and psychosocial-factor studies
Review / scoping review / systematic review / integrative review / meta-analysis	11	35.5%	Dominant in concept mapping, trend analysis, and literature synthesis
Qualitative / mixed methods / reflective	4	12.9%	Dominant in studies of identity experiences, belonging, and social fit

The disciplinary context of the corpus also reveals a clear pattern. Most articles are situated within general STEM, engineering education, and computing/computer science, whereas studies that specifically focus on electrical engineering students remain highly limited. As shown in Table 3, general STEM primarily provides the psychosocial and career aspiration foundation, engineering education serves as the basis for understanding the

formation of engineering identity, and computing provides a strong foundation for the CT domain. The limited number of studies that directly address electrical engineering further reinforces this context as a major research gap. Thus, the descriptive phase not only illustrates the distribution of the corpus but also indicates that the available literature provides more of a conceptual foundation than direct empirical evidence concerning electrical engineering students.

Table 3: Distribution of Articles by Disciplinary Context

Disciplinary context	Tendency in the corpus	Example articles	Meaning for the review
General STEM	Highly dominant	Chen et al. (2024); Dost (2024); Hansen et al. (2024)	Provides a psychosocial and career aspiration foundation
Engineering education	Dominant	Ju & Zhu (2023); Lockhart et al. (2025); Treadway et al. (2025)	Provides the foundation for engineering identity formation
Computing / computer science	Moderately dominant	Osztián et al. (2022); Santhosh et al. (2024)	Provides a strong foundation for the CT domain
Specific electrical engineering	Very limited	Almost no direct focus	Indicates the main research gap

Synthesis of Findings and Patterns of Interdomain Relationships

The cross-corpus thematic analysis indicates that the strongest relationship is not a direct link between CT and career identity, but rather a staged relationship shaped by learning experiences and mediated by psychosocial factors. As summarised in Table 4, the first and most consistent pattern shows that learning experiences contribute to the development of CT. This pattern is supported by studies demonstrating that CT develops through project-based learning, modelling, self-regulated learning, and authentic tasks (Gu et al., 2025; Shin et al., 2022; W. Zhang et al., 2024). The second pattern indicates that learning and practical experiences contribute to identity formation, as reflected in studies on engineering identity that emphasise the role of practical experience, the process of becoming an engineer, and the dynamics of identity development (Ju & Zhu, 2023; Liquete et al., 2025; Lockhart & Rambo-Hernandez, 2024). The third pattern shows that psychosocial factors play a role in shaping identity and career intentions, meaning that self-concept, belonging, and career aspirations bridge learning experiences and professional outcomes (Aguirre Munoz et al., 2025; Chen et al., 2024; Hansen et al., 2024; Jiang et al., 2025). The fourth pattern indicates that the socio-affective context also shapes identity; thus, teamwork, local affect, discrimination, and assessment influence how students make sense of themselves within the field of engineering (D’Anna-Hernandez et al., 2025; Earle et al., 2024; Nieminen, 2025; Treadway et al., 2025).

Table 4: Synthesis of Patterns of Interdomain Relationships

Relational pattern	Core articles	Main findings	Analytical meaning
Learning experiences contribute to the development of CT	Zhang et al. (2024); Gu et al. (2025); Shin et al. (2022)	CT develops through projects, modeling, self-regulation, and authentic tasks	CT is formed as an outcome of intentionally designed learning experiences

Practical experiences contribute to identity development	Ju & Zhu (2023); Liqueete et al. (2025); Lockhart & Rambo-Hernandez (2024)	Engineering identity develops through practical experiences and the process of becoming an engineer	Identity is developmental rather than static
Self-concept and belonging contribute to identity and career intention	Aguirre Munoz et al. (2025); Chen et al. (2024); Hansen et al. (2024); Jiang et al. (2025)	Psychosocial factors mediate the relationship between learning experiences and identity/career orientation	The pathway from CT to identity is likely indirect
Socio-affective context contributes to identity formation	Earle et al. (2024); D'Anna-Hernandez et al. (2025); Treadway et al. (2025); Nieminen (2025)	Social fit, local affect, discrimination, and assessment influence identity	Identity is also shaped by social and institutional environments
The relationship between CT and identity or career remains weakly evidenced	Direct evidence remains very limited	Explicit relationships remain weak in the literature	This constitutes the central gap of the article

When interpreted through a domain-based synthesis, the corpus reveals a relatively clear division of roles. Table 5 shows that the CT domain is predominantly concerned with definitions, assessment, and instructional interventions, whereas the identity domain focuses on identity development, persistence, and career orientation. The domain of linking factors functions as an explanatory mechanism that connects learning experiences with identity and career outcomes. Within the CT domain, the literature positions CT as a core competency for systemic thinking and problem solving, yet it has rarely been linked explicitly to career identity. In the identity domain, the literature affirms that engineering/STEM identity constitutes an important developmental outcome, but CT has not been widely incorporated as a formative factor. Meanwhile, the domain of linking factors indicates that belonging, self-concept, and career aspirations are highly plausible mediators that may explain the relationship between CT and career identity. Based on this synthesis, the relational model most strongly supported by the corpus indicates that learning experiences in engineering and STEM education foster the development of computational thinking, which subsequently strengthens perceived competence, self-concept, sense of belonging, and career aspirations, and ultimately contributes to the formation of career identity or engineering identity. This model represents the central novelty of the review because it integrates CT, psychosocial mediators, and career identity into a single conceptual pathway specifically relevant to electrical engineering education.

Table 5: Synthesis of the Three Research Domains

Domain	Dominant focus	Synthesized findings	Main gap	Implications
Computational thinking	Definitions, assessment, and instructional interventions	CT is positioned as a core competence for problem solving and systemic reasoning	It has not been widely linked directly to career identity	CT needs to be read as an epistemic-professional resource

Career identity / engineering identity	Identity development, persistence, and career orientation	Identity is associated with practical experiences, recognition, engagement, and career intention	CT has rarely been included as a formative factor	Identity can be positioned as the primary outcome
Bridging factors	Belonging, self-concept, aspiration, social support	Psychosocial factors connect learning experiences with identity and career	Explicit relationships with CT remain limited	They serve as conceptual mediators between CT and identity

As summarised in Table 6, CT functions as a cognitive-epistemic capacity that develops through learning experiences, whereas career identity emerges as a professional outcome shaped by self-perception and experiences of socio-academic meaningfulness. In other words, CT does not stand alone as a pedagogical target; rather, it forms part of the developmental trajectory through which students construct their professional identity.

Table 6: Synthesised Conceptual Relationship Model

Relational stage	Core construct	Explanation
1	Engineering/STEM learning experiences	Projects, modeling, practice, programming, authentic tasks
2	Computational thinking	Decomposition, abstraction, algorithmic thinking, reasoning
3	Bridging factors	Self-concept, self-efficacy, sense of belonging, interest, aspiration
4	Career identity / engineering identity	Self-perception as a future engineering professional
5	Professional outcomes	Persistence, engagement, career intention

Unexpected Patterns, Analytical Limitations, and Conceptual Implications

The interpretative phase reveals several patterns that were not immediately apparent during the descriptive and analytical stages. Table 7 shows that one of the most striking patterns is that CT and identity have both developed substantially in the literature, yet they are rarely brought together within a single research model. The relationship that appears more frequently is instead mediated through belonging, self-concept, and career aspirations. Another important finding is that the socio-affective context (such as teamwork, discrimination, local affect, and assessment) plays a particularly strong role in shaping identity. This suggests that cognitive competence alone is insufficient to explain the formation of professional identity. In addition, electrical engineering emerges as a context that has been very minimally explored directly, thereby presenting a clear disciplinary gap.

Table 7: Unexpected Patterns Emerging from the Synthesis

Unexpected pattern	Indication in the corpus	Interpretive meaning
CT and identity are both strong domains, but they are rarely connected	The two domains have developed relatively separately	There is a blind spot in the literature

Bridging factors appear more consistently than a direct relationship between CT and identity	Belonging, self-concept, and aspiration appear more frequently	The relationship is likely indirect
The socio-affective context is highly influential	Teamwork, discrimination, affect, and assessment matter	Competence alone is insufficient to form identity
Electrical engineering is minimally represented as an explicit context	Almost no article directly focuses on it	This is a clear disciplinary gap

The limitations of the analysis should also be stated explicitly to prevent the findings of the synthesis from being overinterpreted. As summarised in Table 8, the first limitation lies in the disciplinary context of the corpus, which remains dominated by general STEM, general engineering, and computing. The second limitation concerns the dominance of quantitative and review-based studies, which makes the synthesis stronger in explaining general patterns than in capturing in-depth individual experiences. The third limitation is that the relationship between CT and identity has rarely been examined simultaneously; therefore, this review produces a conceptual model rather than a direct empirical model. Several articles also originate from non-engineering contexts or from populations other than engineering students, and thus are more appropriately treated as theoretical support rather than primary evidence.

Table 8: Analytical Limitations of the Review

Limitation aspect	Form of limitation	Impact on interpretation
Disciplinary context	Most articles focus on general STEM, general engineering, or computing	Generalization to electrical engineering remains conceptual
Research design	Quantitative studies and reviews dominate	Individual experiential mechanisms remain underexplored
Inter-variable relationships	CT and identity are rarely examined together	The synthesis yields a conceptual model rather than a direct empirical model
Subject distribution	Some articles come from non-engineering or non-engineering-student contexts	They are used as theoretical support rather than core evidence

Nevertheless, this synthesis generates several substantial conceptual implications. As summarised in Table 9, CT needs to be repositioned from merely a learning outcome to an epistemic-professional resource. Identity should be understood as a developmental outcome shaped by experience, recognition, and engagement, rather than as a static psychological attribute. Linking factors need to be positioned as key mediators, while the context of electrical engineering emerges as a highly promising area of novelty. Taken together, the findings of this review generate a set of conceptual propositions, summarised in Table 10. These include the proposition that authentic engineering learning experiences contribute to the development of CT, that CT has the potential to strengthen perceived competence and self-concept, and that sense of belonging and career aspirations serve as bridges toward the career identity of electrical engineering students.

Table 9: Conceptual Implications of the Review Findings

Implication	Explanation	Relevance to the article
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Repositioning CT	CT is not only a learning outcome, but also an epistemic-professional resource	Strengthens the article’s theoretical contribution
Identity as a developmental outcome	Career identity is shaped by experience, recognition, and engagement	Becomes the primary outcome of the synthesis
Bridging factors as mediators	Belonging, self-concept, and aspiration mediate the CT–identity relationship	Become the core of the conceptual model
Electrical engineering as a space of novelty	The characteristics of electrical engineering are highly suitable for integrating CT and career identity	Becomes the article’s specific contribution

Overall, the findings of this review indicate that the international literature has provided a strong foundation for understanding CT, career identity, and linking factors as separate domains. However, it remains insufficiently developed in integrating these three domains within the specific context of electrical engineering students. Therefore, this results section does not stop at mapping the existing literature, but moves toward the construction of a conceptual model that can serve as a basis for future empirical studies and for the development of more integrative practices in engineering education.

Table 10: Conceptual propositions generated from the review

Proposition code	Proposition statement
P1	Authentic engineering learning experiences contribute to the development of students’ computational thinking.
P2	Computational thinking developed through learning experiences has the potential to strengthen students’ perceptions of academic and professional competence.
P3	Self-concept, sense of belonging, and career aspiration function as linking mechanisms between competence and career identity.
P4	Engineering students’ career identity is not formed directly from competence, but through integrated cognitive, social, and affective experiences.
P5	In the context of electrical engineering students, computational thinking has the potential to become a key foundation for the formation of engineering career identity.

Discussion

The synthesis findings indicate that, in higher education, computational thinking (CT) has thus far been more frequently understood as a cognitive competency developed through instructional interventions, assessment, and academic task design, rather than as part of the formation of students’ professional identity. This tendency is clearly reflected in CT studies that focus on the integration of CT into STEM education, instrument development, and the effectiveness of project-based learning, modelling, and self-regulated learning in enhancing students’ computational thinking abilities (Belmar, 2022; Gu et al., 2025). Other studies also demonstrate that CT develops through activities that require problem decomposition, abstraction, algorithmic reasoning, the use of models, and the interpretation of visual representations; therefore, CT cannot be reduced merely to programming skills (Kang et al., 2023; Osztián et al., 2022). These findings show that recent literature has successfully positioned CT as an important intellectual competency in engineering and STEM education. Nevertheless, most of these studies still focus on questions of how CT is taught, measured,

and improved, without seriously examining how this ability shapes the ways in which students perceive themselves within their professional pathways (Lu et al., 2022; Wang et al., 2022). The novel contribution of this review is therefore to move beyond this dominant pedagogical framing by examining CT as part of students' professional self-formation in engineering education.

Based on these findings, this article proposes repositioning CT as an epistemic-professional resource, rather than merely as a learning outcome. This repositioning is grounded in the fact that CT develops through learning experiences that require students to organise their thinking, deal with complexity, and produce solutions that resemble professional engineering practices. In the context of engineering, particularly when students engage with systems, models, algorithms, and technical artefacts, CT is more appropriately understood as a way of knowing and acting within the discipline, rather than merely as an academic ability that can be measured through tests (Shin et al., 2022; Y. Zhang et al., 2026). Articles discussing CT across disciplines and in higher education also show that CT emerges through tasks, projects, and learning artefacts that require students to construct technical understanding explicitly and progressively (Dohn et al., 2022; Guevara-Reyes et al., 2025). From this perspective, CT can be interpreted as an experience of successful thinking that has the potential to build students' perceptions of professional competence. The theoretical implication is that CT is relevant not only for explaining learning outcomes, but also for understanding how students begin to see themselves as individuals who are capable of thinking and working as engineers (Huang & Qiao, 2024; W. Zhang et al., 2024).

This repositioning becomes even more important when connected to the literature on career identity and engineering identity. The synthesis shows that the career identity of engineering students is more appropriately understood as a developmental outcome that is gradually shaped through learning experiences, recognition, engagement, and self-perception, rather than as a psychological attribute that is already stable from the beginning of their studies. Ju & Zhu (2023) show that practice-oriented learning experiences contribute positively to engineering identity, while Liquete et al. (2025) emphasise that the process of moving "from student to engineer" is a trajectory of becoming that takes place throughout higher education. Lockhart & Rambo-Hernandez (2024) demonstrate that engineering identity is dynamic from the first year of study, while Lockhart et al. (2025) further strengthen this foundation by providing validity evidence for the EngID scale as a measure of engineering identity. At a broader level, Jiang et al. (2025) show through meta-analysis that STEM identity is positively correlated with STEM career intentions. Thus, career identity is not merely an affective consequence of the learning process, but a developmental outcome related to students' professional direction.

This review shows that such identity development is rarely explained directly through CT. The identity literature tends to position practical experience, recognition, engagement, and becoming an engineer as the main explanatory factors, whereas the CT literature places greater emphasis on thinking skills and instructional design. It is at this point that the present article offers a distinct conceptual contribution by positioning CT as a cognitive foundation that may support the formation of career identity. When students successfully

solve complex technical problems, model systems, interpret diagrams, or construct valid solutions, they are not merely demonstrating academic ability; they are also beginning to experience themselves as being able to “think like engineers”. This kind of competence experience is highly likely to contribute to the formation of professional self-concept, a sense of recognition, and commitment to an engineering career pathway (Lockhart et al., 2025; Passeggia et al., 2026). Thus, this article extends engineering identity theory by adding an epistemic foundation that has so far received limited attention.

The synthesis also indicates that the relationship between CT and career identity is most plausibly understood through psychosocial mediators, particularly self-concept, sense of belonging, and career aspirations. Chen et al. (2024) show that STEM learning opportunities are related to career aspirations through self-concept and perceptions of STEM professionals, while Aguirre Munoz et al. (2025) demonstrate that interest, academic self-perception, and engagement contribute to the formation of STEM identity and sense of belonging. Hansen et al. (2024) emphasise that domain-specific belonging is a strong predictor of students’ persistence in STEM, while Dost (2024) shows that belonging is interpreted as the experience of being accepted, valued, and feeling that one fits within the STEM community. These findings are important because they show that students do not automatically develop career identity simply because they perform well academically. Identity is more likely to develop when students feel competent, feel that they are part of the community in their field of study, and perceive a professional future that is meaningful and plausible for themselves.

The role of self-concept in this synthesis is particularly central because it serves as a meeting point between learning experiences and professional orientation. Chen et al. (2024) show that the influence of learning opportunities on career aspirations becomes stronger when students possess a positive self-concept, while Aguirre Munoz et al. (2025) demonstrate that mathematics self-concept and mathematics interest are related to STEM identity through specific mediation pathways. Ammar et al. (2024) and Dogaru et al. (2025) further indicate that individual interest, perceived ability, and motivational factors influence students’ success in maintaining their STEM orientation. Taken together, these findings suggest that career identity does not develop directly from exposure to learning, but from the ways in which students evaluate their position within such learning experiences. In the context of this article, CT has the potential to become meaningful for career identity when success in technical tasks is internalised as evidence that students indeed have the capacity to pursue an engineering professional pathway.

Sense of belonging emerges as an equally important mediator. Chan et al. (2025) show that a simple intervention such as faculty–student lunches can increase belonging among engineering students, while Earle et al. (2024) demonstrate that teamwork experiences and a sense of social “fit” within the engineering environment influence whether students perceive the field as suitable for them. D’Anna-Hernandez et al. (2025) further show that discrimination and cultural congruity influence STEM students’ identity and psychological well-being, while Nieminen (2025) demonstrates that assessment is not merely an evaluative tool, but also a mechanism of legitimation and socialisation that shapes students’ positions.

This synthesis indicates that cognitive competence does not automatically lead to professional identity if the socio-academic environment does not provide recognition, safety, and acceptance. In other words, CT may be important, but its impact on career identity may be weakened when students do not experience belonging within the engineering community they enter.

The context of electrical engineering students provides strong theoretical and practical value for integrating these three domains. Theoretically, electrical engineering lies at a clear intersection of computational thinking demands, system modelling, diagrammatic reasoning, and technical problem solving that resembles professional practice. The characteristics of this discipline make CT appear not as an additional ability, but as a core element of engineering thinking itself (Kang et al., 2023; Shin et al., 2022). Practically, electrical engineering students encounter laboratories, projects, simulations, troubleshooting, and hardware–software integration, all of which allow their learning experiences to be translated directly into perceptions of professional competence. This makes the electrical engineering context highly strategic for examining whether CT genuinely contributes to the formation of career identity. Compared with general STEM contexts, electrical engineering provides a more concrete space for observing how technical thinking abilities develop into self-understanding as prospective engineering professionals.

Another added value of the electrical engineering context is that psychosocial mediators can be interpreted more operationally. In general STEM contexts, self-concept, belonging, and career aspirations are often discussed at a relatively abstract level. In electrical engineering, these mediators can be directly connected to students' experiences of working on system projects, solving circuit problems, reading signals, conducting experiments, and collaborating in technical teams. When students successfully navigate these tasks, the possibility of developing technical self-concept, a sense of capability, and a sense of fit with the culture of the field becomes greater. Conversely, when students experience repeated failure, an exclusionary culture, or assessment practices that reinforce feelings of inadequacy, their career identity may weaken even when their cognitive potential is actually high. Therefore, the electrical engineering context provides a sharper basis for understanding how the relationship among CT, psychosocial mediators, and career identity actually operates.

Overall, the novelty of this article lies in its integration of the literature on CT, engineering identity, and linking factors into a more comprehensive relational model for electrical engineering education. While the CT literature has been strong in explaining how CT is taught and measured (Belmar, 2022; Lu et al., 2022), the identity literature has been strong in explaining how students persist and develop career orientations (Jiang et al., 2025; Ju & Zhu, 2023), and the literature on linking factors has been strong in explaining how self-concept, belonging, and socio-academic experiences shape professional outcomes (Aguirre Munoz et al., 2025; Chen et al., 2024), these domains have rarely been integrated within a single conceptual pathway. This article advances existing scholarship by bringing these three domains together in a model showing that engineering learning experiences foster the development of CT, which subsequently strengthens perceived competence, self-concept,

sense of belonging, and career aspirations, and ultimately contributes to the formation of career identity among electrical engineering students. This model not only integrates previously separate fields of inquiry, but also provides a basis for shifting the research agenda in engineering education from examining CT or identity in isolation toward investigating how the two mutually shape one another in the process of becoming an engineering professional.

The limitations of this article should also be acknowledged. The corpus remains dominated by general STEM, general engineering, and computing studies, while studies that explicitly position electrical engineering students as the main subjects are still very limited. The dominance of quantitative studies, reviews, and instrument development also means that the synthesis is stronger in explaining general patterns than highly contextual individual experiences. In addition, the relationship between CT and career identity in this article is constructed primarily through conceptual synthesis, rather than through direct empirical evidence within a single tested model. Nevertheless, these limitations do not diminish the value of this article as a theoretical foundation. Instead, they clarify the next research agenda: to empirically examine whether electrical engineering students with stronger CT indeed demonstrate more positive self-concept, higher belonging, and more robust engineering career identity.

The practical implication of this article is the need for electrical engineering curriculum and instructional design that does not stop at strengthening technical skills, but also helps students reflect on the professional meaning of those skills. Project-based learning, modelling, laboratory work, and troubleshooting experiences can be positioned not only as means of achieving learning outcomes, but also as spaces for career identity formation. At the same time, study programmes need to build an academic climate that supports belonging, recognition, faculty–student interaction, and fair assessment, so that students' cognitive success can be translated into a sense of capability and fit with the engineering profession. In terms of future research, the conceptual model developed in this article needs to be tested through structural equation modelling, mixed methods, or sequential explanatory designs among electrical engineering students. This step is important so that the relationship among CT, psychosocial mediators, and career identity does not remain at the level of review synthesis, but develops into an empirical model that can be used to inform and renew engineering education practices.

Thus, this discussion section emphasises that CT, career identity, and psychosocial linking factors should not be treated as separate domains. Rather, they are better understood as parts of the developmental trajectory of electrical engineering students toward professionalism. The main value of this article lies in its ability to demonstrate that computational thinking can become professionally meaningful when translated into experiences of competence, belonging, and career orientation. Within this framework, electrical engineering students are understood not only as individuals learning to solve technical problems, but also as subjects who are constructing their professional identity through the ways of thinking, learning experiences, and socio-academic relationships they encounter throughout their studies.

Conclusion

This study offers a novel perspective by affirming that computational thinking should not be understood merely as a cognitive ability that supports the resolution of technical problems, but rather as an epistemic-professional resource that contributes to the formation of career identity among electrical engineering students. The synthesis indicates that the relationship between computational thinking and career identity is neither direct nor linear; instead, it operates through the strengthening of perceived competence, self-concept, sense of belonging, career aspirations, and students' professional orientation. The main novelty of this article lies in its integration of computational thinking, engineering identity, and psychosocial linking factors into a comprehensive conceptual model that explains how computational thinking may support the formation of career identity among electrical engineering students. This model broadens the perspective on engineering education by shifting it from a mere arena of competence transfer toward a space for the formation of professionalism and professional identity. The limitation of this article lies in the relatively small number of studies that directly focus on electrical engineering students; therefore, the proposed model requires further empirical testing. This condition also underscores the urgency of future research that can verify the relationship among computational thinking, psychosocial mediators, and career identity in real electrical engineering contexts. The practical implication of this framework is the need for curricula, instructional practices, and assessment systems that not only develop students' technical capacities, but also intentionally foster their perceived competence, self-concept, sense of belonging, career aspirations, and professional orientation. Strengthening computational thinking should therefore be understood as part of a broader strategy to prepare electrical engineering graduates who are not only academically competent, but also secure in their identity, adaptive to change, and ready to enter the professional world. Thus, this article positions electrical engineering education as a strategic space for connecting thinking competencies, learning experiences, and professional self-formation within a more integrative framework of student development.

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