

From Training to Teaching: A Call for a Philosophical Renaissance in Technology and Engineering Education

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Abstract

This study addresses a critical schism within Technology and Engineering (T&E) education: the historical and ongoing preference for skill-based training over philosophically-grounded education. While T&E holds a vital mandate to prepare citizens for a technologically complex world, its pedagogy has often, and increasingly, been detached from the foundational theories that guide holistic intellectual development. This detachment has led to a focus on technical proficiency and vocational outcomes, neglecting the essential critical, ethical, and sociological dimensions of technology education. This paper presents preliminary findings from a pilot survey of pre-service T&E teachers (N=11), which revealed a significant knowledge deficit concerning foundational educational theories and key historical philosophers. Results showed that respondents predominantly cited figures and concepts within the T&E historical lineage (e.g., Sloyd, albeit misidentified as an individual), while demonstrating a pervasive lack of knowledge regarding major theorists (e.g., Dewey, Vygotsky) that underpin modern pedagogy. This knowledge gap suggests a systemic failure in teacher preparation programs to cultivate a Philosophical Content Knowledge (PhCK) necessary for effective practice. This research calls for a philosophical renaissance in T&E teacher education, providing strategies for re-integrating theoretical dialogue to ensure future K-12 educators can truly educate students for technological citizenship rather than merely train them for technical tasks.

Introduction

Technology and Engineering (T&E) education possesses a crucial role in the K-12 curriculum: preparing students to be active, informed, and reflective citizens in a society increasingly defined by technological innovation and complexity. The mandate extends far beyond simple skill acquisition to encompass critical thinking, ethical reasoning, and understanding the social impact of human-made systems. However, a persistent tension exists within the field, especially in the United States, rooted in a historical preference for vocational training over holistic education—a preference that continues to shape and constrain contemporary teacher preparation practices.

The dominant paradigm in T&E often equates successful teaching with efficient transmission of technical skills and the mastery of tools. While technical proficiency is necessary, an over-reliance on this "training" model risks reducing T&E from an intellectual discipline to a purely pragmatic exercise, thereby diminishing its relevance within the broader scope of general education. This approach fails to

prepare future educators to answer the critical question of why technology is taught and how it is best learned, focusing instead only on how to use a specific tool or process.

The intellectual shortfall of this focus on training can be immediately illustrated by considering the utility of specific technical skills. If an educator successfully teaches a student to safely and efficiently operate a table saw, that direct skill will impact the student's life only in the narrow context of carpentry, a trade practiced regularly by a statistically small percentage of the adult population. Conversely, if the context of woodworking is utilized to instill habits of mind and critical cognitive skills—such as systemic planning, precise measurement, anticipating error, and troubleshooting deviations—the educator has impacted the student's daily actions and thought processes for a lifetime. The enduring value of Technology and Engineering Education, therefore, is not in the mastery of the tool, but in the mastery of the reflective and problem-solving process that the tool demands as well as the broader development of the individual using the tool, directly reinforcing the field's mandate for general education.

Problem Statement and Research Question

The core problem addressed by this study is the resulting knowledge gap concerning foundational educational philosophy among pre-service T&E teachers. This gap compromises their ability to employ advanced pedagogical practices, such as constructivism, critical theory, or socio-cultural approaches, which are standard in other K-12 disciplines. The career-long impact is a teaching practice limited to *instruction* rather than *education*.

This paper formally addresses the following research question:

What is the current level of knowledge and application of foundational educational theories among pre-service Technology and Engineering teachers, and how does this relate to the historical philosophical detachment of the field?

This research is significant because the university programs responsible for training these educators must diagnose and correct this deficit to ensure the field's intellectual vitality and continued relevance in a rapidly evolving (and ever-budget conscious) educational landscape.

Literature Review and Theoretical Framework

A rigorous understanding of the current philosophical deficit in T&E teacher education requires tracing the field's historical trajectory and establishing the theoretical distinction between *training* and *education*.

The Philosophical Schism: Training Versus Education

The tension between "training" and "education" is not new to those interested in educational philosophy, however that dichotomy is at the root of much of the discussion of this study. Training is goal-oriented and reductionist, often focusing on developing specific, measurable skills for immediate

vocational or technical application (Diamond & Bulfin, 2025). This approach privileges efficiency over enlightenment.

The field's historical lineage provides clear evidence of this focus. For example, the Russian System of Engineering Training introduced by Victor Della Vos in the 1860s, while pivotal, emphasized the systematic analysis of tool practice into abstract elements and the teaching of these elements for the purpose of producing "technically trained and skilled workers." This system was fundamentally designed for mass production and prioritized "speed in learning" to meet industrial demands. Later, Robert W. Selvidge's contributions during the Industrial Arts era institutionalized this efficiency through the scientific analysis of learning units ("what the learner needs to know and to be able to do"), often resulting in instruction compartmentalized into discrete skill sheets and process steps. The practical reason for this continued focus is clear: it offers measurable outcomes, standardization, and a clear, pragmatic response to workforce needs (Selvidge, 1931).

In contrast, education is transformative, focused on the intellectual, moral, and critical development of the learner as a whole person. Theorists like John Dewey argued for a pragmatic approach where learning through doing is inherently linked to social relevance and democratic citizenship. For T&E, this means moving beyond manipulative performance to the mental functions—the *why* of the work. The goal is to cultivate reflection, judgment, and ethical consideration.

The Problem of "Training": Efficiency Over Enlightenment

The practical focus on training, while historically understandable, carries severe intellectual consequences for pre-service teachers and their K-12 students. Firstly, there is a diminished critical thinking capacity: a training-centric approach equates mastery with the replication of a specific technical process (Warner, 1934). This often leaves little to no cognitive space for students to question the social, ethical, or environmental implications of the technology they are using. Pre-service teachers exposed only to this model learn to manage a shop floor or lab process, but they do not develop the pedagogical agility to facilitate ethical debate or critical inquiry—skills essential for teaching technological literacy. Secondly, there is a resultant loss of intellectual depth: the training model frames T&E content as purely technical knowledge (the *how-to*), divorced from declarative knowledge (the *why-it-matters*). This reinforces the systemic detachment from foundational educational theories (e.g., Constructivism, Socio-Cultural Theory).

A Century of Detachment: Tracing the Historical Divide

The historical roots of T&E education are characterized by a tug-of-war between training and educating, demonstrated further in the field's struggle for identity. The first phase, Manual Training and the general education ideal, saw pioneers like Calvin Woodward adopt the efficient tool processes of the Russian System but crucially integrate them into the public high school curriculum as a means of general

education for all, not just vocational preparation. This ideal was heavily influenced by Otto Salomon's Educational Sloyd, which explicitly organized its manual work on a pedagogic rather than an economic basis and sought formative aims—such as inspiring respect for labor, developing self-reliance, and training in habits of order and exactness (Montgomery, 1954). However, this philosophical vision was challenged by the subsequent rise of vocationalism and the loss of philosophy.

As the field transitioned through Industrial Arts, the growing influence of industry led to a strong emphasis on trade and job analysis. Leaders like Robert W. Selvidge contributed to the scientific analysis of learning units. While effective for standardization, this analysis often compartmentalized instruction into skill sheets and processes, further distancing the curriculum from holistic educational theory (Montgomery, 1954). The result was the establishment of a rigorous system focused on *what* to teach and *how* to teach it efficiently, but falling silent on the overarching philosophical *why*.

This pragmatic narrowing prompted the Technology Education movement and the call for breadth. The movement to rename the field Technology Education was, in part, an attempt to break free from the purely vocational constraints. Prominent figures like William E. Warner championed an expanded vision, emphasizing that Industrial Arts should be concerned with helping *all* students because all are involved in our industrial economy, whether as consumers, producers, or simply recreational users of technology. This vision required educators to be philosophical thinkers, integrating technological facts with social and economic consequences.

Despite this clear historical call for broader education, the structure and content of many T&E teacher preparation programs continue to be shaped by the efficient, skill-focused models inherited from vocational and manual training predecessors. Whether due to university budget, class size, or efficiency, the curriculum plan for the majority of T&E teacher prep programs is dominated by lab-based courses that are also used to prepare technologists, machinists, and trades workers. Few education-focused courses are mandated, with only a small fraction of those already few being taught in department and contextualized within T&E. When educational theory is only discussed in general educational philosophy classes, are students attentive, interested, and understanding the impact within and to their own field of study?

The Conference Shift: Empirical Evidence of Detachment

The content analysis of major professional conferences—the primary forum for academic discourse—provides empirical evidence supporting the claim of significant historical shift from philosophical "education" sessions to pragmatic "training" and content-focused sessions (e.g., technology, STEM, engineering) across the history of the profession.

Quantitative Shift in Conference Session Themes (1978–2014)

The most authoritative data, compiled by Reed and LaPorte (2015) covering 5,639 special interest sessions from the 1978 to 2014 conferences, clearly illustrates the trend. By analyzing specific categories, a distinct preference for implementation and technical content over theoretical curriculum emerges, especially in the modern era. Figure 1 shows the data breakdown of the focus and trends of those sessions across the decades at a leading conference on T&E education.

| Category Type | Core Focus | Mean # of Sessions Per Year (1978–2014) | Trend over Time |
|-----------------------------|---|--|--|
| Curriculum Organizers | Sessions focused on curriculum theories, revision, and history. (Closest proxy for philosophy/pedagogy.) | 41 | Maintained the largest overall number of sessions, but the ratio relative to content dropped, suggesting diluted philosophical focus. |
| Engineering | Sessions focused on engineering design, concepts, and implementation (a form of modern content/training). | 17 | Showed a sharp, significant upward trend beginning around 2005 and peaking around 2010 |
| Computer-Aided Design (CAD) | Sessions focused on specific technical content/software (a direct form of training). | 2.5 | Experienced a high spike from 1984–1992 during the introduction of personal computers, demonstrating that conference content is highly and rapidly responsive to new technologies. |

Figure 1: T&E Conference Focus Over Time

This historical data confirms the decline of the philosophical focus. The consistently high mean for curriculum organizers during the 1970s and 1980s reflects a profession preoccupied with its theoretical foundation (e.g., the Jackson's Mill Curriculum Theory). However, the subsequent sharp, significant upward trend in content-driven sessions such as Engineering, robotics, and automation starting in the mid-2000s demonstrates a pragmatic shift toward alignment with external educational trends. The focus has moved from defining the discipline philosophically to implementing new technical content efficiently, reinforcing the professional environment that privileges practical training over the intellectual work of education.

Current Trends (2015 to Present)

The dominance of content and technology seems to have intensified since the 2014 study cutoff. It is important to note that many professional conference special interest sessions are chosen by a

committee of volunteers based on a number of applications put forth by educators and other professionals in the field. Therefore, the sessions that appear at any conference are more a snapshot of what the field as a whole is interested in or working on than it is indicative of any one association or larger body (Hales, 2010). Recent professional conferences emphasize hands-on workshops, engineering curriculum, and STEM integration, reinforcing the shift from theoretical discourse to practical content delivery.

The current conference model for T&E seems to focus on hands-on workshops and learning sessions paired with a showcase of teacher and preservice teacher work. This model easily lends itself to providing classroom-ready ideas, rather than providing a forum for deep, philosophical debate on educational purpose and theory. Figure 2 breaks down dominant themes, sessions, and theoretical stances across two longer eras of professional development conferences (Reed & LaPorte, 2015).

| Era | Dominant Conference Theme | Focus of Sessions | Theoretical Stance |
|---------------|---|--|--|
| 1970s - 1980s | Educational philosophy, curriculum theory, "What is our purpose?" | Discussions on Pragmateia (social responsibility), and debates over Industrial Arts vs. Technology Education. | Philosophical and Theoretical. Content was often used as a vehicle to discuss curriculum theory (e.g., Jackson's Mill Curriculum Theory). |
| 1990s-2010s | STEM, Engineering Design, specific technology applications (e.g., 3D printing, robotics, drones). | Focus on hands-on workshops, learning sessions, engineering curriculum training, and immediate classroom impact. | Pragmatic and Technical. The emphasis is on "what to do" and "how to do it quickly" (training), often subsuming theoretical questions under the banner of STEM integration and content delivery. |

Figure 2: Themes and Theory of Conference Sessions Over Time

This shift demonstrates that the professional community's collective focus has moved from deep critical inquiry (i.e., *what should the relationship between technology, education, and society be?*) to implementation efficacy (i.e., *how can we efficiently deliver technology content via the STEM framework?*). This institutional shift directly influences university program offerings, faculty research priorities, and, ultimately, the curriculum taught to pre-service teachers, leading directly to the knowledge gap observed in this study.

The Theoretical Gap in Teacher Preparation

Modern teacher preparation is grounded in frameworks like Pedagogical Content Knowledge (PCK), which requires an understanding of how to teach specific content, and Technological PCK, which

integrates technology usage into that teaching. This study posits that T&E educators require a third essential component: Philosophical Content Knowledge (PhCK)—the ability to connect technical content (e.g., 3D printing, circuits, manufacturing) to foundational educational theories (e.g., constructivism, critical theory, social justice) and historical philosophy (e.g., Plato, Dewey). Without PhCK, a teacher cannot move beyond technical demonstration to facilitate critical engagement with technology.

Methodology

Research Design

This study employed a pilot survey to assess the baseline philosophical content knowledge and awareness among pre-service Technology and Engineering teachers. This initial survey was designed to provide indicative data supporting the necessity of a broader, more comprehensive study.

Participants and Context

The institution in the study utilizes a Professional Development School (PDS) model, a full-year apprenticeship experience that immerses pre-service teachers—including those in Technology and Engineering—into a partner K-12 school setting. Teacher candidates are thoughtfully matched with master teachers (mentors) and participate in a two-semester internship that emphasizes a co-teaching methodology, where the mentor and intern share responsibility for instruction and planning. In the Fall semester, interns are placed in the field three days per week building toward the Spring semester with a more traditional everyday schedule for student teaching. This rigorous, co-teaching structure allows interns to seamlessly integrate university coursework with practical application, moving from observing and assisting to confidently leading the classroom over the course of the full academic year.

The study surveyed a convenience group of pre-service T&E teachers (N=11) enrolled in a professional methods course at one regional comprehensive university in the northeast United States. Participants were upper-level undergraduate students starting their first of two placement semesters in the PDS model. These students had already completed the vast majority of their educational preparation and were beginning the capstone year, the final product of their respective teacher preparation curricula.

Instrumentation

The survey instrument included three key sections designed to reveal knowledge levels:

1. Foundational Theory Knowledge: Open-ended questions asking participants to list: (a) key educational theories (e.g., constructivism, behaviorism) and (b) key educational philosophers/theorists (e.g., Dewey, Piaget, Vygotsky).
2. Field-Specific Knowledge: Open-ended questions asking participants to list influential figures, concepts, and movements specifically within the T&E education field.
3. Matching: Pairing foundational educational theorists (Skinner, Vygotsky, Gardner) with their key contributions or theories (behaviorism, zone of proximal development, multiple intelligences).

Results

The pilot study of pre-service T&E teachers provided compelling evidence of a philosophical knowledge gap, directly supporting the central hypothesis. Key findings of foundational and field-specific concepts and figures are broken down over figures 3 and 4 respectively.

| Category | Responses | Key Findings |
|---|---|--|
| Foundational Educational Theorists/Philosophers | Socrates (2), Sloyd (4), University professors (4), Unsure/None (5) | Only two names were listed. The inclusion of Socrates suggests a generalized, high-level awareness, while Thomas Wright (a lesser-known, field-specific figure) indicates a search for a figure familiar to the field rather than the broad pedagogical canon. |
| Foundational Educational Theories | None, No clue, Unsure (7), Hands on, Lecture (2) | The overwhelming majority of responses were blanks, "None," "no clue," or "Unsure." There was a near-total absence of reference to major educational theories such as Constructivism, Behaviorism, Critical Pedagogy, or Pragmatism. |

Figure 3: Foundational Theory Knowledge of Survey Respondents

| Category | Responses | Key Findings |
|---|---|--|
| T&E Field-Specific Educational Theorists/Philosophers | University-Specific Professors (4), Unsure/None (7) | Again primarily blank or unsure, a few respondents named professors within their own university, more students misidentified Sloyd as an individual philosopher rather than a foundational theory in the history of T&E. A few did identify key figures such as William E. Warner. |
| T&E Field-Specific Educational Theories or Historical Movements | Name Change Identifiers (5), Industrial Revolution (3), Unsure/None (2) | Aside from those that misidentified Sloyds in an earlier question, the most common responses fell into the category of name changes of the field's title over time including Manual Training, Industrial Arts, and Technology Education. |

Figure 4: Field-Specific Knowledge of Survey Respondents

The ability of the cohort to identify key T&E leaders (like Warner) but not fundamental theorists (like Dewey) strongly suggests that their preparation has focused heavily on the internal history and structure of the subject matter while neglecting its necessary connection to the broader educational

philosophy taught in colleges of education. This is a critical finding: the pipeline is successfully training students in the *trade* of T&E teaching but failing to *educate* them in the profession of pedagogy.

The Knowledge Gap Quantified

The most powerful indicator of the problem was the "Unsure/None" category. A significant number of responses indicated a complete lack of awareness, stating "None," "no clue," "Unsure," or "None that I can think of right now." This outcome indicates that the knowledge of foundational theory is not simply *weak*, but non-existent for a critical mass of future educators. This validates the problem statement: T&E teacher preparation has effectively detached itself from the core theoretical discourse of its parent field (Education).

Discussion and Implications

The field's emphasis on technical proficiency, or training, may do more than just limit pedagogical discourse; it may create a critical workforce pipeline problem. Individuals who possess a deep-seated passion for the technology itself—the machines, the processes, and the efficient execution of technical tasks—are precisely those who are highly valued and highly compensated within industry (e.g., advanced manufacturing, engineering, and prototyping). For this segment of the population, the path of a K-12 educator, with its corresponding constraints on salary and access to cutting-edge equipment, represents a significant economic opportunity cost. Therefore, the dominant paradigm of T&E teacher preparation—a system largely focused on technical training—actually incentivizes its most qualified technical candidates to pursue more lucrative careers outside of education.

Conversely, the individuals who are intrinsically motivated to become educators are those driven by a commitment to holistic development—the philosophical, critical, and intellectual work of shaping young minds. These candidates are often seeking a profession defined by meaningful pedagogy, ethical inquiry, and socio-cultural impact. When they encounter a T&E preparation program or a professional environment that prioritizes the efficient teaching of technical skills over these broader, more profound educational aims, their intrinsic motivation is not cultivated, and their professional needs are not met. The resulting lack of qualified candidates entering the field may be, therefore, a direct consequence of the profession's philosophical imbalance: by focusing on the values of the technician (training), the field fails to recruit and retain individuals motivated by the calling of the teacher (education).

Conclusion and Future Research

The Imperative for a Philosophical Renaissance

The evidence presented—from the historical detachment of the field to the modern-day knowledge gap found in the preliminary study—leads to one unavoidable conclusion: the Technology and Engineering teacher education pipeline is structurally deficient in cultivating Philosophical Content Knowledge (PhCK). This is not a matter of semantics but of professional survival. For too long, T&E

programs have relied on the paradigm of training, viewing the K-12 educator primarily as a skilled technician transferring a set of specialized processes. The findings beg the question whether this focus may undermine the recruitment of intrinsically motivated educators and severely limits the pedagogical efficacy of those who do enter the field.

To reclaim its intellectual footing within the larger educational landscape, pre-service T&E programs must urgently update their curriculum to fully incorporate overarching educational theories and movements. The need is twofold:

- **To Elevate Pedagogy:** Integrating theories like constructivism, critical pedagogy, and pragmatism provides future educators with the theoretical tools to transform a technical demonstration into a meaningful learning experience. It empowers them to structure a simple design challenge to facilitate profound critical reflection on topics such as ethics in design, the societal impacts of technological systems, and the moral responsibilities of a creator. Without this intellectual toolkit, the T&E educator remains a skill instructor, rather than a master teacher.
- **To Secure the Future Workforce:** By emphasizing philosophical and critical inquiry, the field validates the intrinsic motivation of candidates who are driven by the transformative power of education, not merely by the mechanics of the machine. This shift transforms T&E from a technically focused trade into a rigorous, relevant academic discipline, finally positioning the educator as an essential contributor to general education and attracting the high-caliber, philosophically grounded individuals necessary for long-term sustainability.

Advancing the Research Agenda

The stark and definitive results of this pilot study—particularly the near-total absence of reference to foundational theories and theorists (Dewey, Vygotsky) paired with the only slightly higher knowledge of T&E-specific theories and theorists (Warner, Sloyd)—provides initial justification for a substantial expansion of this research. This is not just an anecdotal observation; it is an indicative empirical finding pointing to a systemic, structural issue within university teacher preparation programs.

Further research beyond the pilot study could be necessary to:

- **Quantify the Systemic Issue:** Formally measure the extent of the PhCK deficit across a diverse, national sample of pre-service teachers, moving this finding from a preliminary observation to an authoritative baseline.
- **Inform Curricular Reform:** Provide the evidence base necessary for policy change, and the development of new, theory-driven methods courses.
- **Establish a Scholarly Framework:** Re-center the professional conversation on the field's former tradition of theoretical inquiry, helping the field articulate its scholarly contribution to the greater field of education.

The future quality of Technology and Engineering instruction in K-12 schools depends directly on the intellectual rigor we demand from our university preparation programs today. The time for a philosophical renaissance is now. That philosophical renaissance has been well past due. In 1900, when sharing his philosophy, Calvin Woodward wrote, “It was believed that school should not be converted into a factory, and that the more it resembled a factory, the less it would resemble a school. . . . The science of education should dominate the methods of the drawing-room and the department of biology (Woodward, 1900). It is time that our field resembles a school more than a factory and our teachers entering the field embody educators rather than technologists.

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