

# North Carolina CTE Dual Enrollment Pathways Labor Market Alignment Dashboard

## *Technical Documentation*

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### 1. PURPOSE AND OVERVIEW

This dashboard is a descriptive planning tool designed to help Career and Technical Education (CTE) program planners and policymakers assess the relationship between student enrollment patterns and projected local labor market conditions across North Carolina. It addresses the following question: Do students tend to enroll in CTE Dual Enrollment (DE) program areas with the strongest projected labor market outlook?

The dashboard presents two types of information side by side for each of 16 NC Prosperity Zone sub-regions (plus a statewide summary): (1) the distribution of CTE DE participation across program areas over roughly the past decade and (2) projected labor market indicators for each program area over the coming decade. The composite labor market outlook index summarizes relative labor market strength, and a correlation coefficient quantifies the overall degree of alignment between enrollment concentration and labor market outlook in each sub-region.

**The dashboard is intended to be descriptive and inform conversations.** It does not prescribe program decisions. Enrollment patterns reflect many factors beyond labor market opportunity, including student interest, instructor capacity, community context, and program history. This tool is one input to a broader planning process, not a verdict on any individual program.

#### **Relationship to the Broader Study**

This dashboard is a companion product to the Workforce-Focused Dual Enrollment Pathways in Rural North Carolina study, a three-year evaluation conducted by RAND in partnership with the Early College Research Center at UNC Greensboro and MDRC. The study uses quasi-experimental propensity score methods to estimate the relationship between CTE DE participation and postsecondary enrollment, credential attainment, and earnings. The dashboard addresses one component of that broader study: whether historical CTE DE participation patterns align with projected local labor market conditions.

For descriptive patterns of participation and credential attainment by program area, see [HERE](#). For descriptive labor market outlook by program area, see [HERE](#).

## 2. SCOPE

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**Programs:** 36 CTE DE program groupings, defined using four-digit Classification of Instructional Programs (CIP) codes. Where closely related CIP codes map to very similar occupational sets, they are combined into a single grouping (see Section 4).

**Geography:** 17 geographic areas: one statewide (North Carolina) and 16 NC Prosperity Zone sub-regions. Six sub-regions are classified as predominantly Urban/Suburban; ten are classified as Largely Rural/Town. The latter are defined as sub-regions in which more than 50% of students attend schools in rural or town locales, according to National Center for Education Statistics (NCES) locale codes.

**Participation period:** Nine cohorts of students entering 11th grade in academic years 2012–13 through 2020–21, followed through 12th grade (academic year 2021–22). Total CTE DE enrollment across these cohorts was approximately 36,400 students from rural areas statewide.

**Labor market projection period:** 2024–2034 (10-year occupational projections from the NC Department of Commerce).

## 3. DATA SOURCES

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### *A Note on Core Terminology*

Three conceptual elements underlie the analysis, and understanding them is essential to interpreting any measure in the dashboard.

**CIP code:** A Classification of Instructional Programs (CIP) code is a standardized four-digit code identifying an educational program area. CIP codes classify what students study; they are assigned by the institution and appear on enrollment records. For example, CIP 5202 identifies Business Administration, Management and Operations; CIP 5107 identifies Health and Medical Administrative Services.

**SOC code:** A Standard Occupational Classification (SOC) code is the federal system for classifying jobs. SOC codes identify what workers do. For example, SOC 29-1141 identifies Registered Nurses; SOC 41-1011 identifies First-Line Supervisors of Retail Sales Workers. Labor market projections from the NC Department of Commerce are reported by SOC code.

**CIP-to-SOC crosswalk:** A reference table that links each CIP program code to the set of SOC occupation codes most associated with graduates of that program. The crosswalk is the bridge between the enrollment data (organized by CIP code) and the labor market data (organized by SOC code). Because a single program can prepare students for multiple occupations, and because multiple programs may prepare students for some of the same occupations, the crosswalk is a many-to-many mapping. The implications of this mapping for how measures are computed are discussed in Sections 4 and 5.

### 3.1. CTE Dual Enrollment Participation

*Source: NC Community College System administrative records for dual enrollment students attending public high schools in North Carolina.*

This dataset includes students who enrolled in a CTE DE pathway and participated in at least one CTE DE course in 11th or 12th grade under North Carolina’s Career and College Promise (CCP) dual enrollment program. Records are linked to program areas via the 4-digit CIP code associated with the student’s

enrollment record. Each student record can be linked to a high school and, through that, to a Prosperity Zone sub-region, enabling sub-region-level participation analysis.

Nine cohorts of entering 11th graders (academic years 2012–13 through 2020–21) are pooled; the final cohort is followed through 12th grade in 2021–22. Records were originally coded at the 6-digit CIP level and rolled up to the 4-digit level for analysis. Programs originally coded under a broad “other health professions” category (CIP 5199) were excluded, as most students in that pathway did not pursue a CTE-designated course. Also excluded were students who concurrently enrolled in both the CTE DE pathway and the CCP “College Transfer” pathway, since a CIP code for the student’s CTE DE pathway was not available in the data for those students.

### 3.2. Labor Market Projections

*Source: NC Department of Commerce Labor & Economic Analysis Division (NC LEAD), 2024–2034 Occupational Employment Projections ([LINK](#)).*

NC LEAD publishes 10-year occupational employment projections for each of the state’s 16 Prosperity Zone sub-regions and for North Carolina as a whole. Projections are reported at the 6-digit SOC code level and include projected total job openings, projected net employment change, and annual earnings at the 10th, 25th, and 50th percentiles. These are the best publicly available forward-looking occupational data for NC sub-regions and serve as the primary source for all labor market measures in the dashboard.

### 3.3. CIP-to-SOC Crosswalk

*Source: National Career Clusters® Framework, published by Advance CTE ([LINK](#)).*

The crosswalk links CIP program codes to the SOC occupation codes for which each program is considered preparatory. For each CIP code in scope, the crosswalk identifies the set of occupations that students completing that program are likely to enter. Where multiple CIP codes are grouped into a single program area (see Section 4), the union of the SOC codes linked to all member programs is used, with each occupation counted once regardless of how many member programs link to it.

The crosswalk reflects nationally established program-to-occupation relationships and may not perfectly capture local hiring patterns in North Carolina, particularly for programs tied to regional industries or state-specific licensing requirements (see Limitations, Section 8).

### 3.4. NC Star Jobs Rating

*Source: NC Department of Commerce Labor & Economic Analysis Division (NC LEAD) ([LINK](#)).*

The Star Jobs rating is a composite job quality score assigned at the SOC occupation level by NC LEAD. It accounts for wages, projected growth, and projected demand, with adjustments based on typical education and training required for entry to the occupation. For each CTE program area, the dashboard presents an employment-weighted average Star Jobs rating across all linked SOC occupations within the sub-region. Because the occupational composition of a program area and the regional employment weights both vary across sub-regions, Star Jobs ratings vary across sub-regions for the same program area.

## 4. PROGRAM GROUPINGS

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### 4.1. The Problem of Occupational Overlap

Many CTE program areas prepare students for overlapping sets of occupations. When two programs link to largely the same jobs, treating them as separate entries inflates the apparent size of the labor market for each: the same pool of jobs gets counted twice. This section describes how we identify programs with substantial overlap and how we handle them in the dashboard.

### 4.2. Measuring Overlap: Two Approaches

We quantify the occupational similarity between any two CTE programs using two complementary measures.

#### *Jaccard Similarity (symmetric)*

The Jaccard similarity score measures the proportion of SOC occupations shared by two programs, relative to all occupations linked to either program.

A score of 0% means the two programs share no linked occupations; a score of 100% means they link to exactly the same set of occupations. This measure is symmetric: the score for A compared to B is identical to the score for B compared to A. It captures the degree of structural overlap in occupational coverage but does not account for differences in the scale of employment associated with each program.

#### *Direct Job Overlap (asymmetric)*

The direct overlap measure asks a different question: what share of the employment in Program A's linked occupations falls in occupations also linked to Program B?

This measure is asymmetric: the A-to-B score and the B-to-A score are often quite different. A large A-to-B score means that most of Program A's labor market, measured by employment in its linked occupations, is also covered by Program B, so the two programs are competing for the same jobs in meaningful volume. The reverse (B-to-A) may be small, indicating that Program B covers a broader occupational set that extends well beyond the overlap. This asymmetry is important: it identifies not just whether programs overlap, but whether one program is effectively subsumed by another in terms of labor market reach.

### 4.3. Merge Criteria

Not every degree of overlap warrants treating programs as a single group. Some occupational overlap between programs in adjacent fields is normal and expected. We combine programs into a single grouping only when the overlap is substantial enough that maintaining separate entries would meaningfully inflate labor market counts. Two additional constraints apply:

- Programs considered for merging must belong to the same two-digit CIP family (i.e., the same broad subject area), ensuring that programs in unrelated fields are not grouped even if their occupation lists happen to overlap.
- The merge criteria apply a two-tier threshold, with both criteria satisfied before a pair is flagged as a candidate for merging. First, a Jaccard minimum: at least 10% of the union of all occupations linked to either program must be linked to both. This floor guards against combinations driven by a single large, shared occupation when the two programs' overall occupational profiles are largely distinct. Second, a directed overlap threshold (evaluated using

statewide employment data): either the directed overlap in both directions is at least 50%—each program accounts for at least half of the other's linked job market—or the directed overlap in at least one direction is at least 80%, meaning one program's linked job market is largely subsumed within the other's.

#### **4.4. Group Formation**

When programs A and B are flagged as a merge pair, and programs B and C are also flagged, all three are assigned to the same group, even if A and C were never directly compared. This transitive grouping is handled using a connected-components algorithm, which ensures that all directly or transitively linked programs are consolidated.

The algorithm proceeds as follows: each program begins as its own group. The algorithm then iterates over all flagged merge pairs and merges the groups of any two programs that are paired, repeating until no further merges occur (typically two to three passes). The result is a stable partition in which every program belongs to exactly one group.

Applied to the 4-digit CIP codes in scope, this procedure yields 36 final program groupings, most composed of a single CIP code and others combining two or more closely related codes.

#### ***Multi-code groupings:***

The groups below represent cases where two or more four-digit CIP codes were combined using the approach described above.

- 43XX — Criminal Justice and Corrections: Combines CIP 4301 (Criminal Justice and Safety Studies) and CIP 4304 (Security and Protective Services)
- 11XX — Computing: Combines CIP 1101 (Computer and Information Sciences), CIP 1104 (Information Technology), and CIP 1108 (Computer Software and Applications)
- 15XX-A — Engineering Core: Combines CIP 1500 (Engineering Technology, General), CIP 1501 (Architectural Engineering Technology/Technician), and CIP 1502 (Civil Engineering Technology/Technician)
- 15XX-B — Electrical and Electromechanical Engineering Technologies: Combines CIP 1503 (Electrical/Electronic Engineering Technologies, General) and CIP 1504 (Electromechanical Engineering Technology/Technician)
- 51XX — Medical Assisting, Clinical/Medical Science, and Allied Professions: Combines CIP 5108 (Allied Health and Medical Assisting Services) and CIP 5110 (Clinical/Medical Laboratory Science/Research and Allied Professions)
- 16XX — Language: Combines CIP 1601 (Linguistic, Comparative, and Related Language Studies and Services) and CIP 1616 (American Sign Language)

#### **4.5. How Groupings Are Handled in Measures**

For multi-code program groupings, all labor market measures are computed at the group level. The set of linked SOC occupations is the union of all member programs' crosswalk entries, with each occupation counted once regardless of how many member programs link to it. Employment, openings, and wage figures for the group reflect the full combined occupational pool, without double-counting.

## 5. MEASURES

### 5.1. Participation Measure

| Measure                                                                                          | Description                                                                                                                                              |
|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Total Participants                                                                               | Cumulative CTE DE enrollment in the program area across all 9 cohort years (11th graders entering 2012–13 through 2020–21, followed through 12th grade). |
| <b>Note:</b> To protect student privacy, participation counts between 1 and 9 are shown as “<10” |                                                                                                                                                          |

### 5.2. Labor Market Measures

All labor market measures are linked to CTE program areas via the CIP-to-SOC crosswalk (Section 3.3). Where a program area maps to multiple occupations, values are computed as employment-weighted averages (wages and Star Jobs ratings) or sums (openings and net growth) across all linked SOC codes within the sub-region.

| Measure                     | Description                                                                                                                                                                              | Units                     |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Job Openings (10-Year)      | Projected total job openings in linked occupations over 2024–2034. Includes both expansion demand (net new positions) and replacement demand (openings due to turnover and retirements). | Count                     |
| Net Job Growth              | Projected net change in employment in linked occupations over 2024–2034. Positive values indicate net employment gains; negative values indicate net losses.                             | Net jobs                  |
| Median Annual Earnings      | Employment-weighted median annual wage across linked occupations, 2024 dollars (50th percentile).                                                                                        | \$/year                   |
| Entry-Level Annual Earnings | Employment-weighted 10th percentile annual wage across linked occupations, 2024 dollars. Approximates earnings for workers at the lower end of the wage distribution.                    | \$/year                   |
| NC Star Jobs Rating         | Employment-weighted average NC LEAD Star Jobs rating across linked occupations in the sub-region.                                                                                        | Rating (weighted average) |

### 5.3. Composite Labor Market Outlook Index

The composite labor market outlook index summarizes overall labor market strength for each program area in a single score, enabling direct comparison across programs within a sub-region. It is adapted from the approach developed in a recent study of labor market alignment of high school CTE programs in West Virginia (Mulhern et al., 2025; see References).

**Component measures.** The index draws on three labor market measures: total projected job openings, projected net job growth, and median annual earnings.

**Standardization within sub-region.** Because the three component measures are on different scales (counts of openings, counts of net employment change, and dollars of wages), they cannot be combined directly. Each component is converted to a z-score within each sub-region, computed across all 36 program groupings for that sub-region:

$$z = (\text{value} - \text{sub-regional mean}) \div \text{sub-regional standard deviation}$$

This standardization makes the index a relative measure: it reflects how each program's labor market outlook compares to other programs in the same local labor market, not how it compares to programs in other regions. Index values should not be compared across sub-regions.

**Composite score.** The composite labor market outlook index is the equal-weighted average of the three z-scores (weight = 1/3 each). Index values near zero indicate average labor market outlook for that sub-region; positive values indicate an above-average outlook; negative values indicate a below-average outlook.

#### 5.4. Alignment Correlation

For each sub-region, the dashboard reports a Pearson correlation coefficient ( $r$ ) between the composite labor market outlook index and a standardized measure of program participation within the sub-region (calculated as a z-score). A stronger positive correlation indicates that programs with greater enrollment concentration also tend to have stronger labor market outlooks; that is, historical enrollment patterns are better aligned with projected future demand. The correlation is computed across all 36 program groupings within each sub-region.

## 6. RANKINGS

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Rankings use standard competition ranking (also called "1-2-2-4" ranking): programs tied on a measure receive the lowest (best) rank in the tied group. For example, two programs tied for 2nd both receive rank 2, and the next program receives rank 4. When tied programs need to be ordered for display, the 4-digit CIP code is sorted in ascending order; tied programs retain the same rank. Rankings are computed separately within each sub-region and for each measure; rank 1 = best on that measure.

## 7. DASHBOARD STRUCTURE

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The dashboard is organized into tabs by labor market measure, with the ability to select a Prosperity Zone sub-region or view statewide data. Each tab presents participation rankings alongside a labor market measure: the composite labor market outlook index, median earnings, entry-level earnings, the NC Star Jobs rating, projected net job growth, or total projected job openings. A separate data tab provides the full ranked dataset for all 36 program groupings across all measures, along with the underlying raw data used to produce the rankings.

## 8. ADDITIONAL CONSIDERATIONS

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Several additional factors underlying our analysis merit mention. Some are limitations of the analysis; we include the others to provide dashboard users with additional context.

**1. The participation and projection periods do not overlap.** Student enrollment data span academic years 2012–13 through 2021–22; labor market projections cover 2024–2034. Comparisons between them are necessarily prospective: they describe whether accumulated enrollment patterns point toward projected future demand, not whether students' outcomes matched the labor market conditions that prevailed during the enrollment period. Users should interpret alignment measures as forward-looking rather than as a retrospective evaluation of student or program performance.

**2. Linked job counts encompass workers at all credential and experience levels.** Projected openings and employment totals reflect all workers in linked occupations, regardless of the educational credentials or years of experience typically required for each occupation. Volume measures should be interpreted as reflecting the full occupational labor market linked to each program area, not only the subset directly accessible to two-year college completers or recent high school graduates. Prior analyses showed that CTE DE participants go on to pursue a range of postsecondary credentials, from short-term certificates to bachelor's degrees; therefore, we did not restrict the set of occupations based on required education or training levels. The entry-level earnings measure (10th percentile wage) partially addresses this limitation: because it reflects wages at the lower end of the earnings distribution, it may better approximate the earnings prospects of workers entering these occupations than the median does.

**3. The CIP-SOC crosswalk is national, not North Carolina-specific.** The National Career Clusters Framework crosswalk reflects national patterns in how instructional programs relate to occupations. NC graduates may enter different occupational mixes than the crosswalk implies, particularly for programs tied to regional industries prominent in specific parts of NC or to state-specific licensing and certification requirements.

**4. The composite labor market outlook index is a relative, within-sub-region measure.** Because index scores are standardized within each sub-region, they reflect a program's standing relative to other programs in the same local labor market. A program ranked first in a rural sub-region with limited occupational diversity may have weaker absolute demand than a program ranked fifth in a large urban sub-region. Index scores and rankings should not be compared across sub-regions.

**5. Residual occupational overlap can remain across program groupings.** The grouping procedure described in Section 4 reduces double-counting of labor market demand among closely related programs, but some overlap persists among distinct groupings that share a subset of occupations.

**6. Projection uncertainty is greater for smaller sub-regions.** Occupational employment projections for smaller Prosperity Zone sub-regions are based on smaller samples and carry greater uncertainty than statewide or large-metro estimates. In low-population sub-regions, small differences in projected employment can meaningfully shift program rankings.

## 9. REFERENCES

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## ABOUT THIS STUDY

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This study built upon the research team’s prior analyses of North Carolina’s Career and College Promise program. The study focused on CTE dual enrollment pathway program areas in rural settings, defining rural and town locales according to National Center for Education Statistics locale codes. Program areas were identified by the first four digits of the CIP code associated with a student’s dual enrollment record in NC Community College System data. Programs under a broad “other health professions” category were excluded because most students in that pathway did not complete a CTE-designated course. The analysis pooled nine cohorts of entering 11th graders from academic years 2012–13 through 2020–21, with students required to have participated in at least one CTE DE course in 11th or 12th grade to be counted as having actively pursued a CTE pathway.

The analysis covers all 16 NC Prosperity Zone sub-regions. Rural sub-regions are defined as those in which more than half of students are enrolled at a rural or town school; six sub-regions are not considered rural: Asheville, Charlotte, Greensboro, Raleigh-Durham, Wilmington, and Winston-Salem. The remaining ten sub-regions are classified as rural.

If you want to talk with someone about this work, please reach out to Brian Phillips at RAND, [Brian\\_Phillips@rand.org](mailto:Brian_Phillips@rand.org) or Julie Edmunds at the Early College Research Center at UNCG, [jadmund@uncg.edu](mailto:jadmund@uncg.edu).

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