

Don't Replace One Paper Ceiling With Another: Technical Appendix

Data Sources:

- Lightcast worker profiles, 2015–2026
- Lightcast job postings, 2021–2026

Determining routes into occupations:

Identifying transitions into target occupations. We examined qualifying job transitions in Lightcast worker profiles occurring from 2021 to 2026 to understand how workers typically move into three target occupations: computer user support specialists, database architects, and computer & network systems administrators. We define a transition as movement between a pair of consecutive jobs held by the same worker. The earlier job must end on or after January 1, 2021, and the later job must begin within two years of that end date and no later than January 1, 2026, with no intervening job recorded between the two. When more than one job could serve as the earlier job in a pair (for example, when a worker held overlapping or multiple jobs), we selected the job ending closest to the start of the later job. A worker's first observed job was treated as a transition from "no prior job" and was classified alongside workers entering a new occupation after recently completing a degree or non-degree credential.

Classifying pathways. Each transition into a target occupation was assigned to one of four mutually exclusive pathway categories. We first determined whether the worker entered from the same or a different occupation. For workers entering from a different occupation, we determined whether they had recently completed a non-degree credential or degree (associate's, bachelor's, or higher) at any point from two years before starting the new job up to three months after starting it. When both a recent degree and non-degree credential were completed, the degree took precedence.

- **Within-occupation movers** — Workers whose immediately preceding job was in the same occupation, regardless of whether they completed a recent degree or non-degree credential.
- **Recent degree** — Workers entering from a different occupation who completed a degree within the recent window. This category includes workers who also completed a recent non-degree credential in addition to the recent degree.
- **Recent credential only** — Workers entering from a different occupation who completed a non-degree credential within the recent window but did not complete a degree during that period.
- **No new credential or degree** — Workers entering from a different occupation who completed neither a degree nor a non-degree credential within the recent window.

"Recent" refers only to completion within the window defined above (two years before through three months after the start of the new job), and workers in these categories may hold additional degrees or credentials earned earlier in their careers. Because a worker can make multiple qualifying transitions between 2021 and 2026 and may appear in different pathway categories across those transitions, reported shares represent transitions rather than unique workers (Table 1). National salaries for each occupation were estimated using Lightcast job postings from 2021 to 2026.

TABLE 1. ALL TRANSITIONS INTO THREE TECHNICAL OCCUPATIONS, 2021–2026.

Pathway Category	Computer User Support Specialists	Database Architects	Computer & Network Systems Administrators	Total
Recent Degree	72,272 (14.6%)	42,288 (14.4%)	14,869 (12.8%)	129,429 (14.3%)
Recent Credential Only	62,781 (12.7%)	37,625 (12.8%)	18,454 (15.9%)	118,860 (13.1%)
Within–Occupation Movers	123,139 (24.8%)	37,736 (12.8%)	24,789 (21.4%)	185,664 (20.5%)
No New Credential or Degree	237,641 (47.9%)	176,882 (60.1%)	57,782 (49.9%)	472,305 (52.1%)
Total	495,833 (100.0%)	294,531 (100.0%)	115,894 (100.0%)	906,258 (100.0%)

Classifying non-degree credentials. Non-degree credentials were identified from two fields in Lightcast worker profiles:

- **Certifications:** Entries in the raw certifications field were classified as non-degree credentials when a completion date was available, excluding entries containing terms associated with degrees, coursework, or ongoing enrollment (e.g., associate, bachelor, high school, coursework, still enrolled).
- **Education:** Entries in the raw education field were first screened to exclude terms associated with degrees, coursework, enrollment, or academic recognition (e.g., associate, postdoctoral, high school, coursework, classes, still enrolled, scholarship, award, honor, graduated). Remaining entries were identified as non-degree credentials when they contained credential-related terms such as license, certificate, certification, badge, or microcredential, or commonly recognized credential names and abbreviations such as CompTIA, PMP, CDL, LPN, RN, and CNA.

Determining workforce outcomes for CompTIA A+ credential earners:

Identifying treatment and comparison groups. We next examined workforce outcomes associated with non-degree credentials through the example of CompTIA A+, a non-degree credential that aims to build skills related to information technology (IT) and other tech occupations. Using difference-in-differences analysis, we compared workers who earned a CompTIA A+ credential with those who did not by collecting treatment and comparison groups from Lightcast worker profiles for individuals recording at least one job on or after 2015. This set of work histories (58.2 million) was then used to define the following:

- **Treatment group** — Individuals who earned a CompTIA A+ credential from CompTIA with completion on or after January 1, 2021.¹
- **Comparison group** — Individuals who did not complete the selected credential at any point in their recorded career history.

¹To be considered a CompTIA A+ credential earner, profiles must have a credential listed in education or certifications that matches both the provider (i.e., comptia) and the following keywords within the credential title: comptia a+, comptia a+ ce, comptia a+ certification, comptia a+ certified.

Work histories for the 69,253 profiles within the treatment group were collected at selected checkpoint dates relative to the credential end date (baseline) for each profile: two years before, one year before, six months before, at the credential end date, six months after, one year after, and two years after. At each checkpoint, the educational status of the profile was assigned temporally as STAR or BA+ where:

- STARS are workers Skilled Through Alternative Routes, defined here as those with no bachelor's degree or higher listed with an end date on or before the given checkpoint.
- BA+ workers are those who have completed a bachelor's degree or higher on or before the given checkpoint date.

Years of experience was also calculated for each profile as the time from the earliest job start date to the baseline date. Profiles from the comparison group were matched to the treatment group based on the following criteria: job, industry, state, date, and education status relative to the baseline timepoint (see Table 2), and years of experience.

TABLE 2. TREATMENT AND COMPARISON GROUP TIERED MATCHING CRITERIA.

Matching Criteria	Tier 1	Tier 2	Tier 3
Job & Industry*	exact	exact	exact
STAR/BA+ status	exact	exact	exact
State	exact	exact	N/A
Date of job	end date is no earlier than 6 months prior to the baseline date	must overlap the calendar-year range ± 1 year from the baseline year	same as Tier 2
Years of experience	ranked, closest match preferred among candidates that already passed the filters above		

*Jobs were identified using the 6-digit Standard Occupational Classification (SOC) from Lightcast profiles. Industry was identified using the North American Industry Classification System (NAICS), 2-digit code.

Using tiered matching, each treatment profile was matched to up to three comparison profiles. In cases where more than three comparison profiles matched to a single treatment profile, comparisons were narrowed to the top three based on years of experience. Each treatment profile was first matched to unique comparison profiles. If no unique comparison profile was available, a previously used comparison profile was recycled to meet the minimum of one match. Treatment profiles without matching comparison profiles were excluded from the difference-in-differences analysis (see *Comparison using difference-in-differences* below). This treatment group represents 65,688 credential earner profiles (Table 3). The work histories at each checkpoint were then collected for each comparison profile relative to the matched treatment checkpoints. Treatment and comparison groups were further limited to those that had not previously held a technical role in the checkpoint periods leading up to the credential completion date, resulting in 45,243 treatment profiles.²

² Relevant technical roles were chosen based on the skills built from the CompTIA A+ credential. Relevant roles were those containing the following keywords: information technology, IT, database, computer, software, information systems, cybersecurity, systems administrator, network, technology, and/or technical support specialist.

TABLE 3. SELECTION OF TREATMENT AND COMPARISON PROFILES FOR THE COMPTIA A+ CREDENTIAL.

	Treatment profiles*						Comparison profiles**	
	All		Matched		Matched & non-relevant job pre-credential		Matched one or more treatment profiles**	
Education	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
BA+ profiles	28,678	41.4%	27,659	42.1%	18,560	41.0%	48,662	40.7%
STAR profiles	40,575	58.6%	38,029	57.9%	26,683	59.0%	70,841	59.3%
Total	69,253	100.0%	65,688	100.0%	45,243	100.0%	119,503	100.0%

*Education status is checked at credential completion end date.

**Unique comparison profiles matched to treatment profiles with no relevant job before credential completion; 890 were matched to more than one treatment profile.

Estimating salaries. To understand how credential completion affects workers' salary outcomes, annual salaries were estimated using pooled Lightcast job postings from 2021 to 2026. Salaries were estimated for each worker at each checkpoint based on their state, employer, and occupation using a tiered matching approach. For each worker's job at a given checkpoint, at least 20 matching postings were required to pass the following tiers:

- First, median salary was estimated using the most granular match: 6-digit SOC occupation, employer, and state. Jobs that did not meet this threshold moved to the next level.
- Next, median salary was estimated using occupation and state.
- Finally, median salary was estimated using occupation alone at the national level.

Checkpoints that did not meet the 20-posting threshold at any of the three levels were excluded from the analysis.

Comparison using difference-in-differences. To estimate the salary difference associated with CompTIA A+ credential completion, we calculated a matched-pairs difference-in-differences (DiD) at each checkpoint.

Where:

i = treatment worker

c = matched comparison group

t = checkpoint

r = reference checkpoint (baseline)

N = number of treatment workers

$Y_i^T(t)$ = treatment worker i 's salary at checkpoint t .

$\bar{Y}_i^c(t)$ = average salary across worker i 's matched comparison(s) at checkpoint t .

Growth relative to reference checkpoint (r): For each treatment worker, salary growth was calculated as the change in their estimated salary at a given checkpoint relative to their salary at credential completion (the reference point).

$$G_i^T(t) = Y_i^T(t) - Y_i^T(r) \quad [\text{treatment worker } i\text{'s growth}]$$

$$G_i^c(t) = \bar{Y}_i^c(t) - \bar{Y}_i^c(r) \quad [\text{mean growth across } i\text{'s matched comparison(s)}]$$

The same growth calculation was applied to the average estimated salary across that worker's matched comparison profile(s). To create a matched pair, the salaries of each treatment worker's comparison workers were averaged into a single value.

Per-person DiD at checkpoint t : The per-person DiD is the treatment worker's salary growth minus their matched comparison(s)' salary growth over the same period (i.e., how much more (or less) their salary grew relative to workers with similar job, industry, state, education status, and experience who did not earn the credential).

$$DiD_i(t) = [Y_i^T(t) - Y_i^T(r)] - [\bar{Y}_i^c(t) - \bar{Y}_i^c(r)] \quad [\text{per-person DiD}]$$

Summary DiD estimate at checkpoint t (across N treatment workers): These per-person DiD estimates were then averaged across all matched treatment workers to produce a single DiD estimate at each checkpoint.

$$DiD(t) = (1/N) \cdot \sum_{i=1}^N DiD_i(t) \quad [\text{summary DiD}]$$

The total N represents every treatment worker included in a given sample (e.g., the full matched sample or the subset of workers who did not hold a relevant job prior to earning the credential). This reflects everyone who was successfully matched to at least one comparison worker. However, not every worker has an estimated salary at every checkpoint: a worker's job at a given point in time may not have had enough comparable job postings to produce a reliable salary estimate (see *Estimating salaries* above). As a result, the number of workers actually contributing to the DiD estimate can be smaller than the total N , and can shift from checkpoint to checkpoint. For the difference-in-differences figure shown on p.8 of the report, 35,771 matched pairs had valid salary estimates at one or more checkpoints, representing 79% of the matched pairs who did not hold a relevant technical role pre-credential (Table 3).

Comparing salaries for credential earners across education:

To compare salary trajectories between STAR and BA+ CompTIA A+ credential earners, specifically among those without prior experience in a relevant technical role, we calculated the average estimated salary of treatment workers at each checkpoint, and restricted the sample to workers who did not hold a relevant job at credential completion or at any of the prior checkpoints (two years, one year, or six months before). Workers were then classified as STAR or BA+ based on their education status at credential completion, and were retained only if that status remained the same at every subsequent checkpoint (six months, one year, and two years after credential completion). This excludes workers who earned a bachelor's degree following credential completion. This comparison reflects average salaries within the treatment group alone, and does not require a treatment worker to have been matched to a comparison profile. There are 22,960 STARs and 18,619 BA+ treatment workers who completed a CompTIA A+ credential on or after January 1, 2021, did not work in a relevant role prior to credential completion, had valid salary estimates at one or more checkpoints, and maintained stable education status post-credential completion.



About Opportunity@Work

Opportunity@Work is a nonprofit social enterprise dedicated to advancing economic opportunities for the more than 75 million U.S. workers who are Skilled Through Alternative Routes (STARs) instead of through a bachelor's degree. Opportunity@Work's research capabilities inform the nation's understanding of STARs and uncover insights that show how to make positive change within regions and industries. The organization engages with corporate, public sector, and philanthropic partners to directly address the barriers that STARs face and equip organizations to make hiring STARs for higher-wage roles the norm. Learn more at [**www.opportunityatwork.org**](http://www.opportunityatwork.org).