Artificial Intelligence, Teacher Tasks and Individualized Pedagogy

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Roadmap

- **Artificial Intelligence (AI)**...
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- In education, ongoing controversy on **automated writing evaluation (AWE)** systems...
  1. natural language processing;
  2. machine learning algorithms.

- Supporters of AWE argue that...
  - AWE systems may relax teachers' **time constraints**.
  - They may also help **human capital constraints**.
- Critics...
  - AWE is "*blind to meaning*" and **cannot emulate human behavior**.

1. How are these *ed* techs **incorporated into instruction**?
2. What are the effects on **students' outcomes** that proxy for learning?

- We study **two** *ed* techs designed to improve scores in the **argumentative essay** of the National Secondary Education Exam (ENEM).

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- Focus on bottlenecks to effective pedagogy in **public schools**.
- They use different combinations of **artificial** and **human intelligence**:
  1. Pure AWE *ed* tech: standard AWE system;
  2. Enhanced AWE *ed* tech: timely "supervision" step by human intelligence.

Roadmap

- Key determinant of access to **post-secondary education (PSE)** in Brazil:

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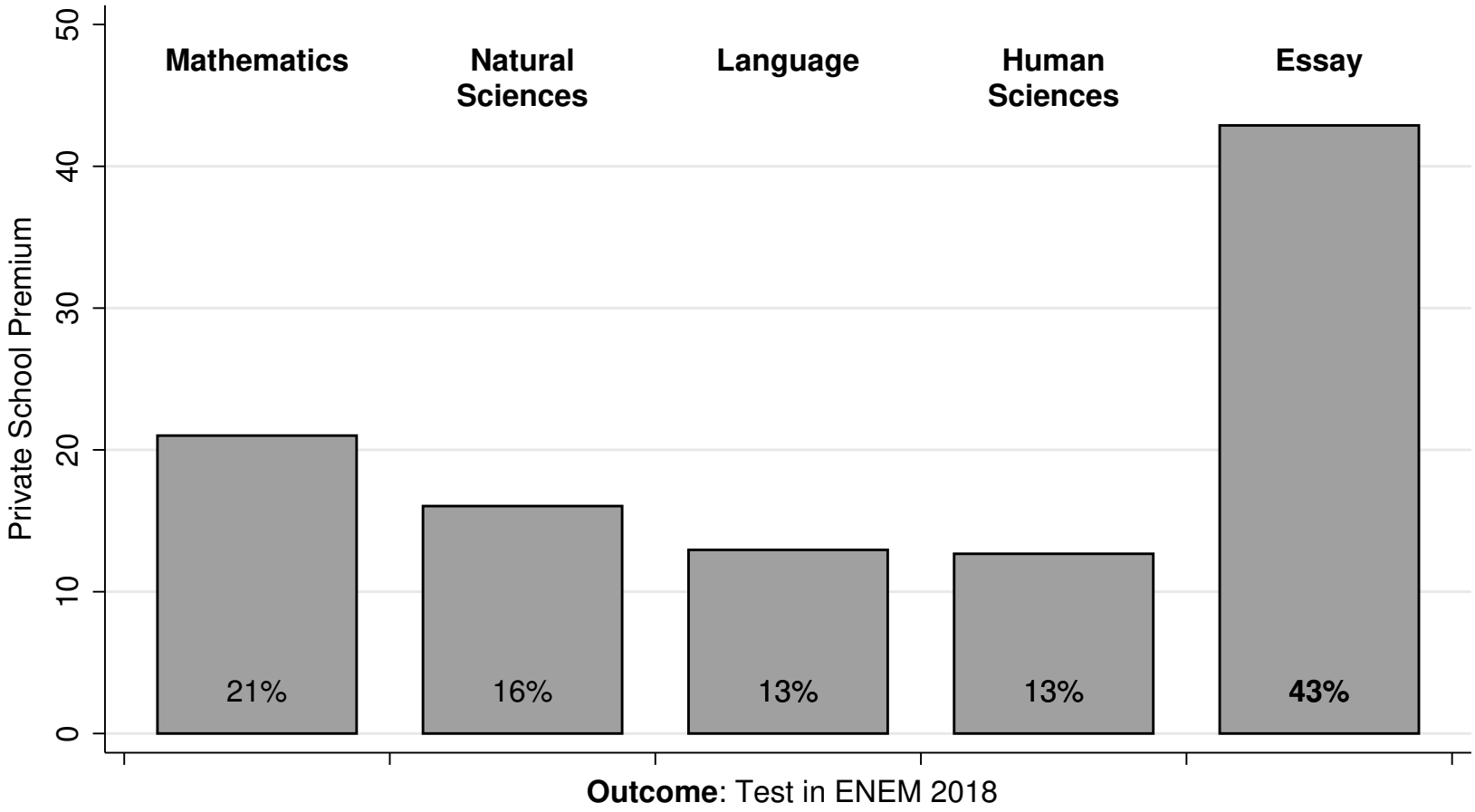
- Large differences between quality in **public** and **private schools** is apparent.

Figure: Private School Premium is Particularly Large in the Essay



Essay Topic — 2019

"The Democratization of Access to Cinema in Brazil"

Syntactic Skills

Formal written norm + and a "fluid" text built on **argumentative connectives** within and across paragraphs.

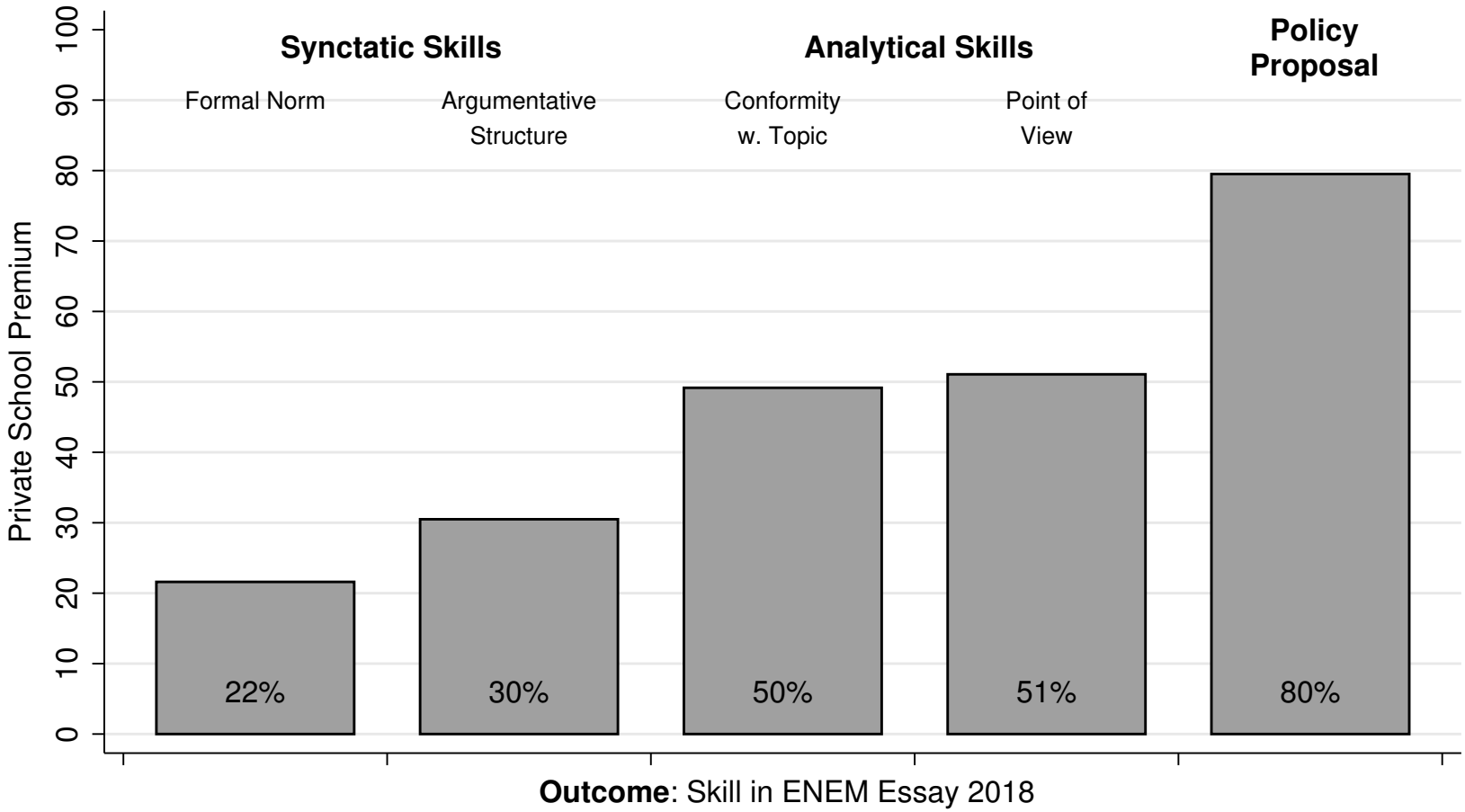
Analytical Skills

Ability to interpret and use information from the motivating elements + from knowledge acquired throughout the schooling process.

Policy Proposal Skills

Intervention consistent with the thesis developed in the essay.

Figure: Private School Premium is Increasing in Skill Sophistication



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2. Large differences between public and private students.
3. Large potential number of beneficiaries from the *ed* techs.

- **Field experiment** in Espirito Santo, Brazil, in 2019, 178 schools (app. 19,000 students):
  1. **Pure** AWE arm: 55 schools
  2. **Enhanced** AWE arm: 55 schools
  3. Control Arm: remaining 68 schools

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- 5 writing activities (ENEM training essays) throughout the year.

Roadmap

Primary Outcome — Did AWE Systems Improve ENEM Writing Scores?

i. Official ENEM 2019 essay scores (in total, and *per* skill);

ii. "Unofficial" ENEM 2019 essay scores (in total, and *per* skill).

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Estimation

We fit the following regression to study effects on the primary outcome:

$$Y_{ise} = \tau_{\text{ITT}}^{\text{Enhanced}} W_s^{\text{Enhanced}} + \tau_{\text{ITT}}^{\text{Pure AWE}} W_s^{\text{Pure AWE}} + \mathbf{X}'_{ise}\mathbf{\Pi} + \varepsilon_{ise}$$

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Estimation

The models for mechanisms and secondary outcomes are similar:

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Inference

We present p-values:

1. based on standard errors clustered at the strata level — **??**
2. based on randomization inference using the protocol and 1,000 placebos
3. adjusted for multiple hypothesis testing — **?**

and summary indexes based on **?**.

Roadmap

Figure: **95% + of Teachers** Used the Platform to Assign Essays

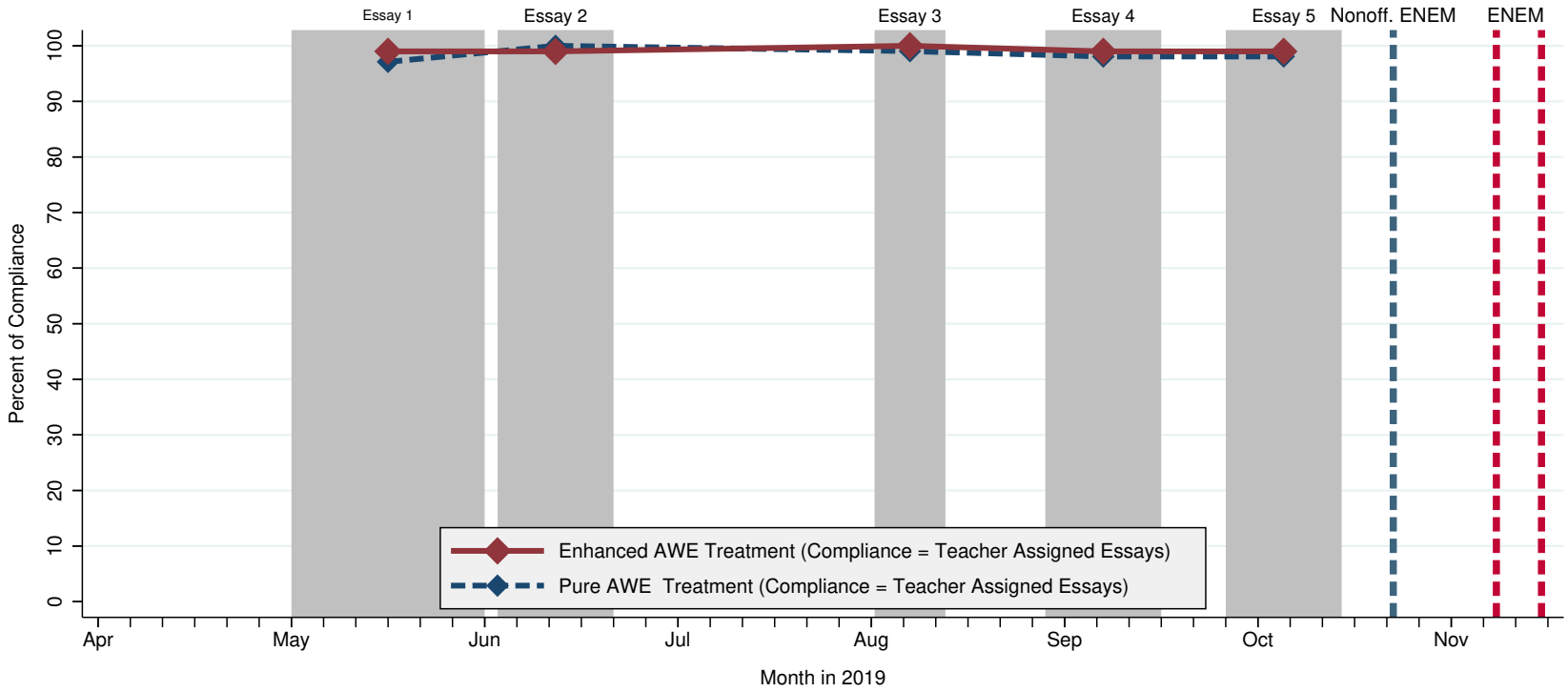


Figure: **75-80% of Students** Used the Platform to Submit Essays

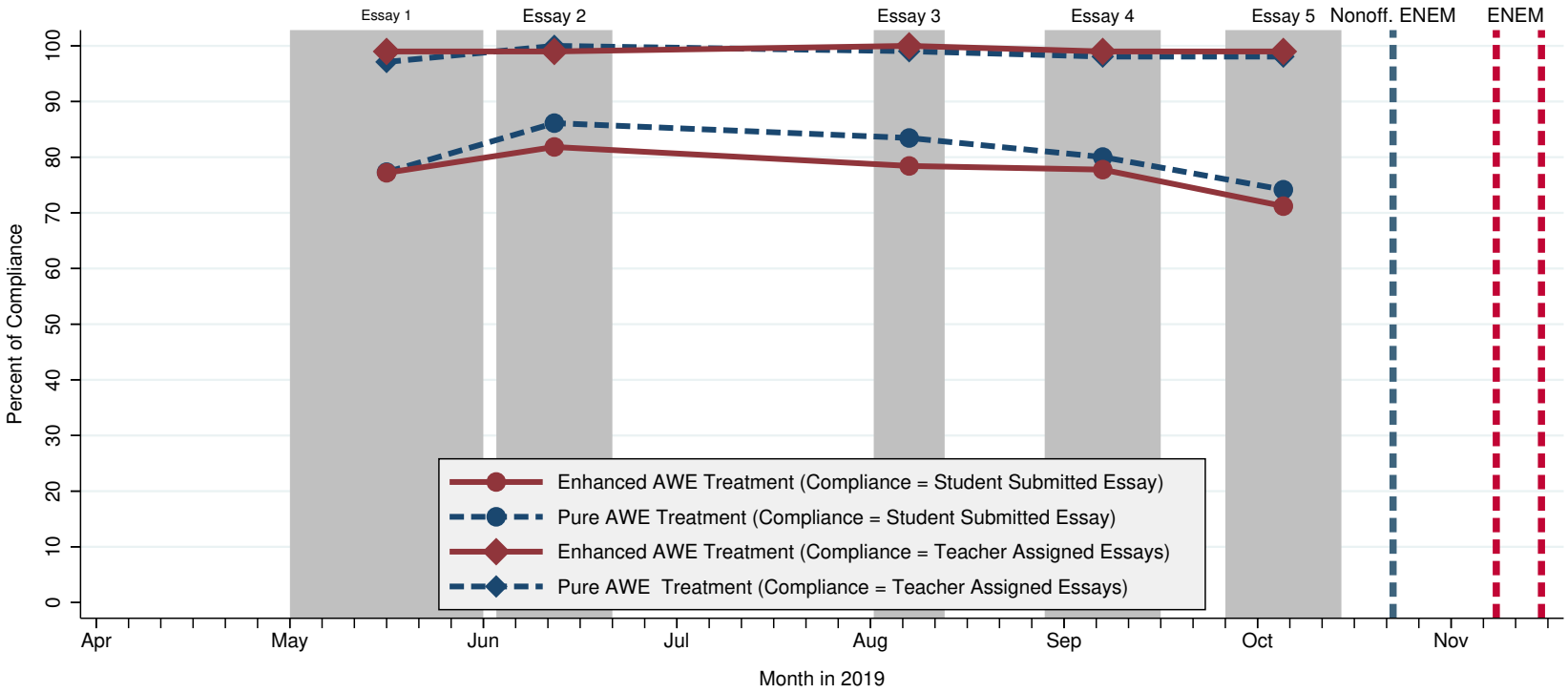


Figure: ITT Effects on ENEM Writing Scores

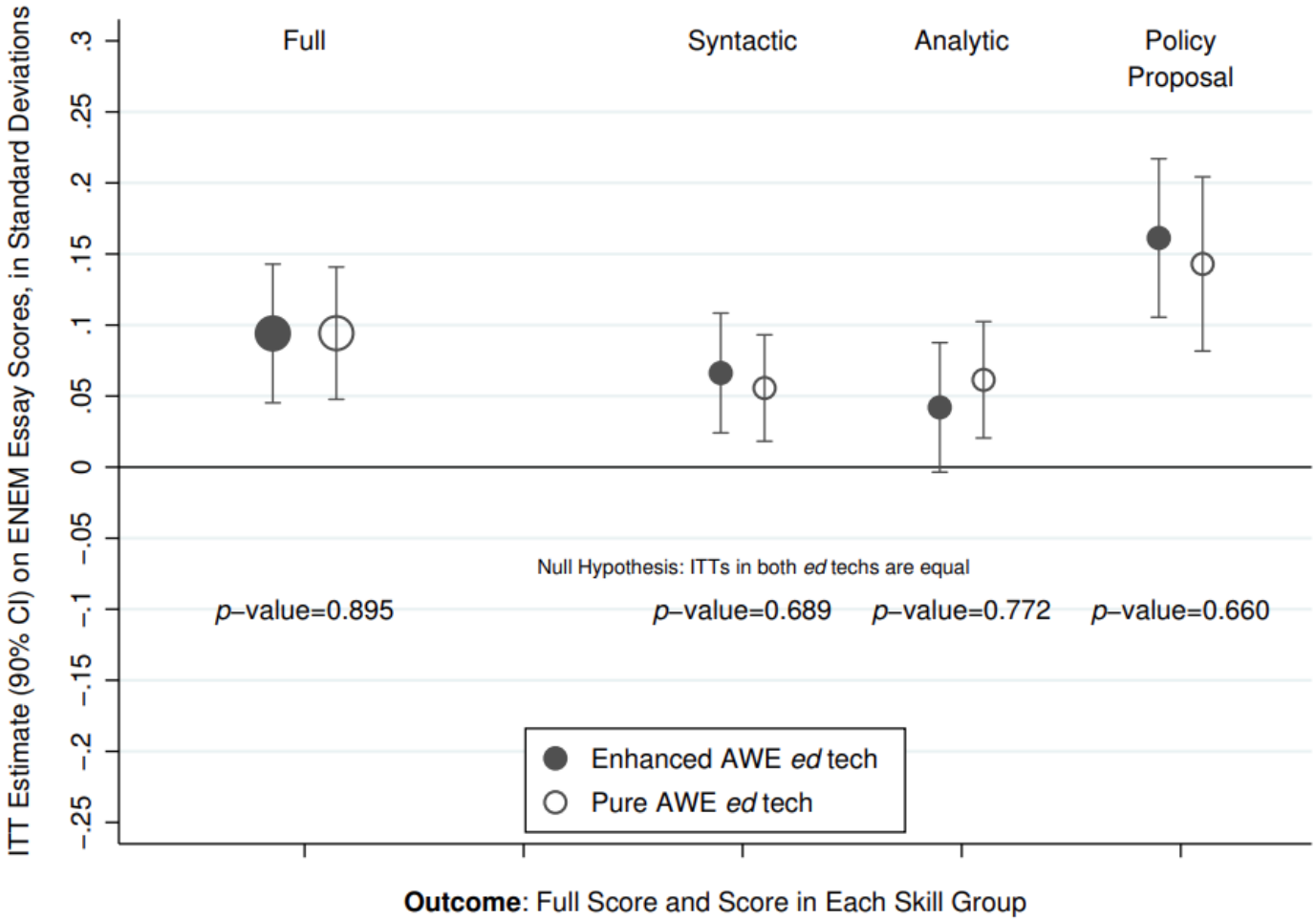


Figure: *ed* techs Had **Positive Impacts on the Full Score**

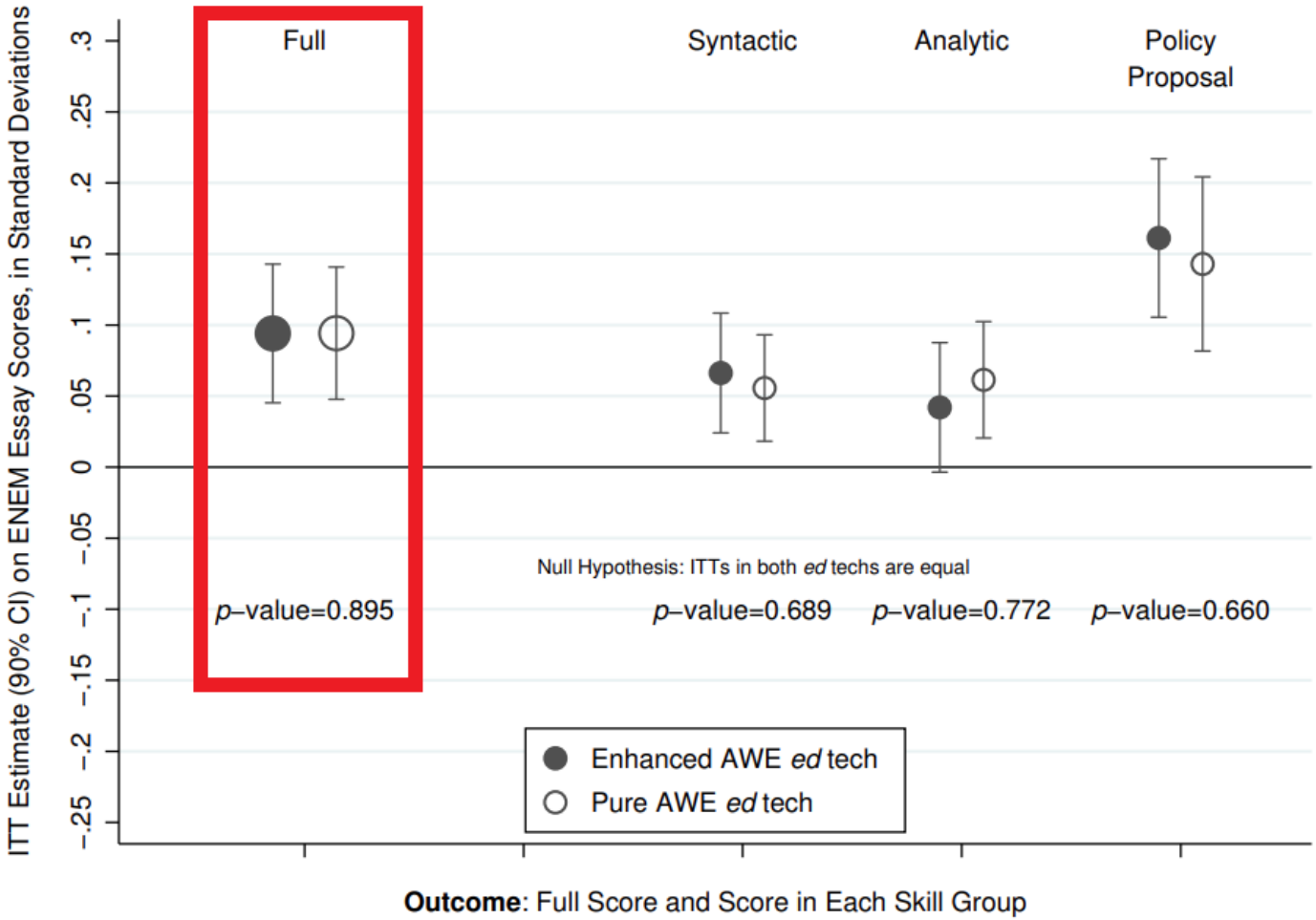


Figure: *ed* techs Had **Very Similar** Impacts on the Full Score

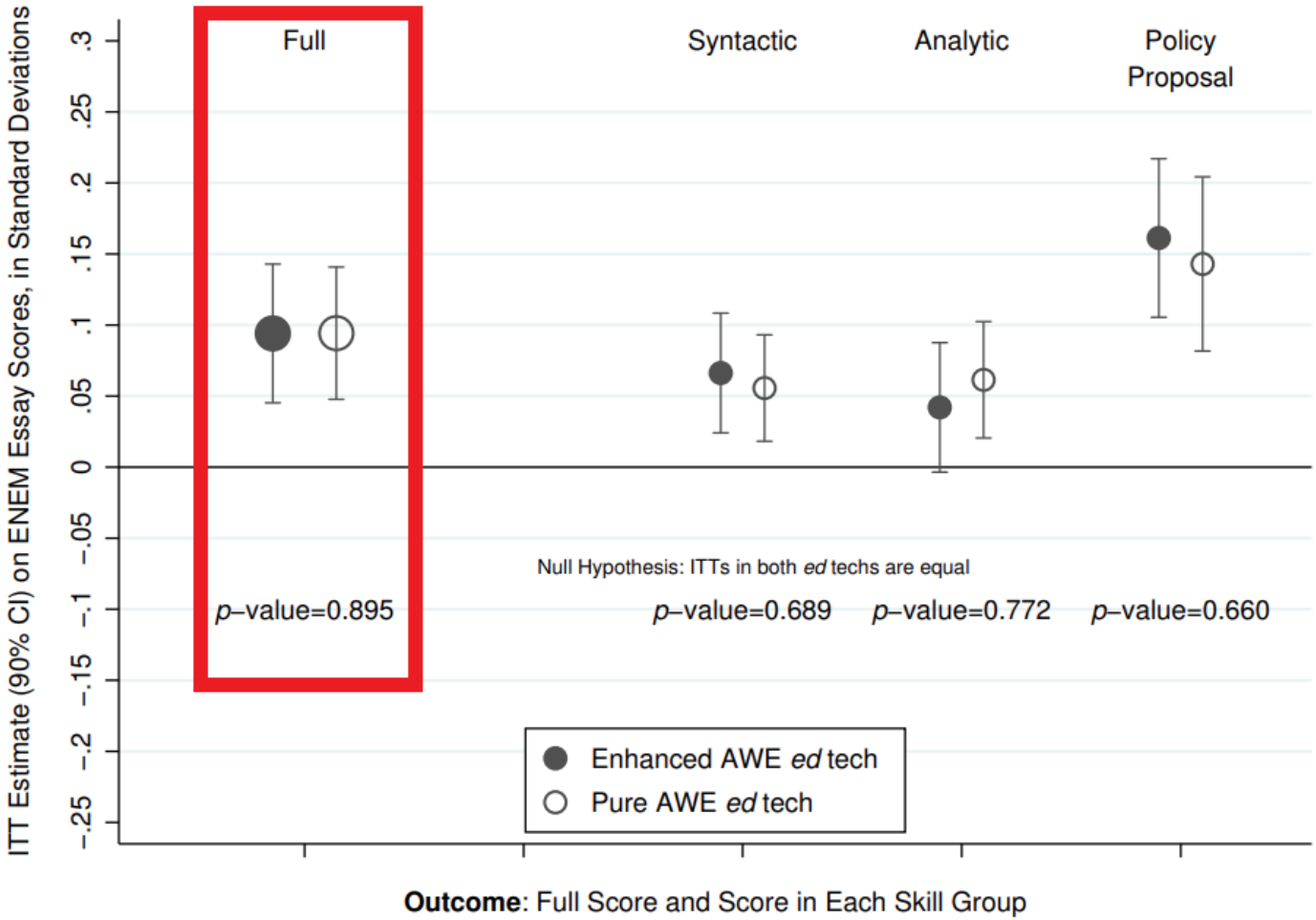


Figure: Effects Were Channeled By **Very Similar Effects on All Scores**

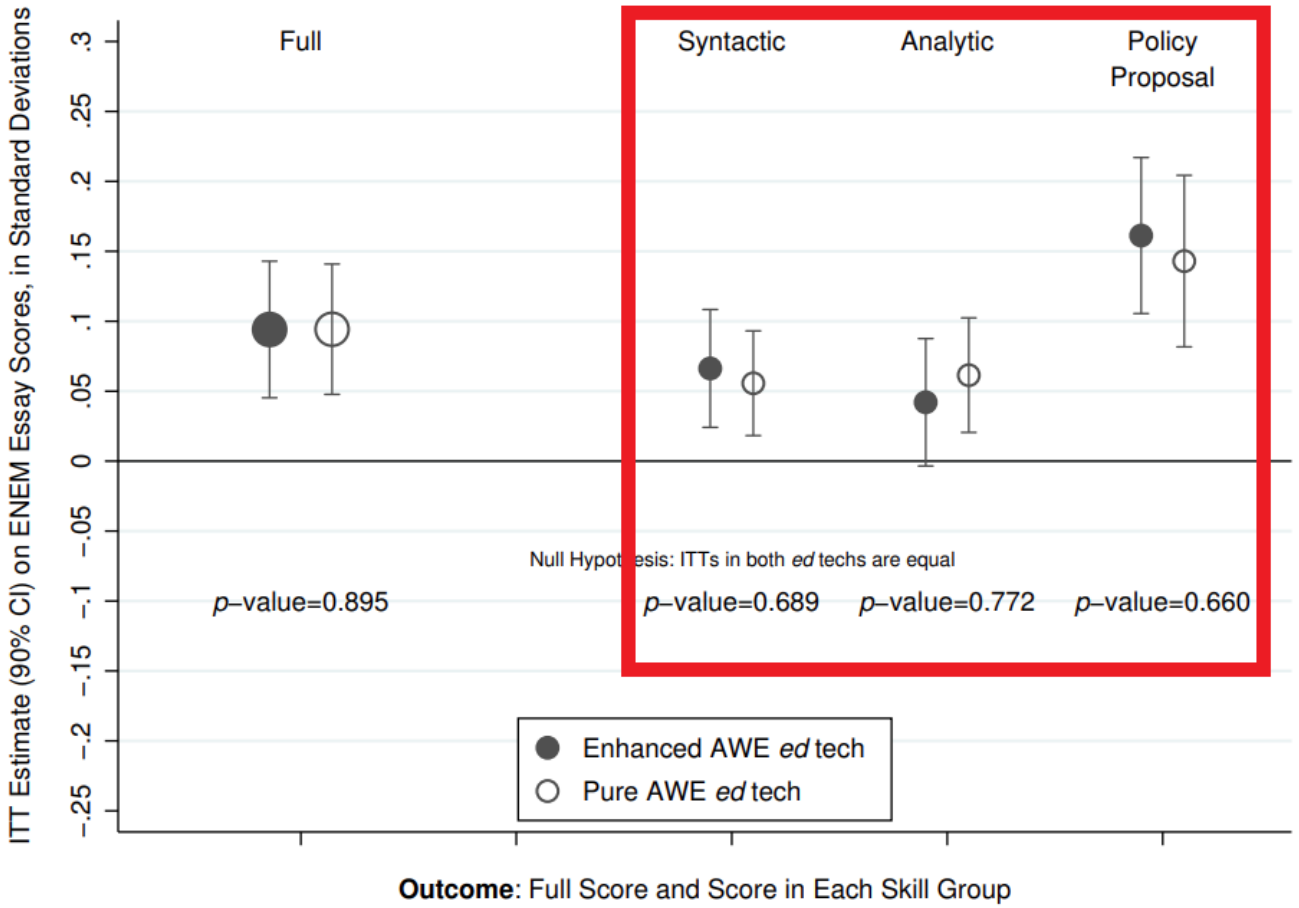


Figure: ITT Effects on Training, Feedback and Individualized Pedagogy

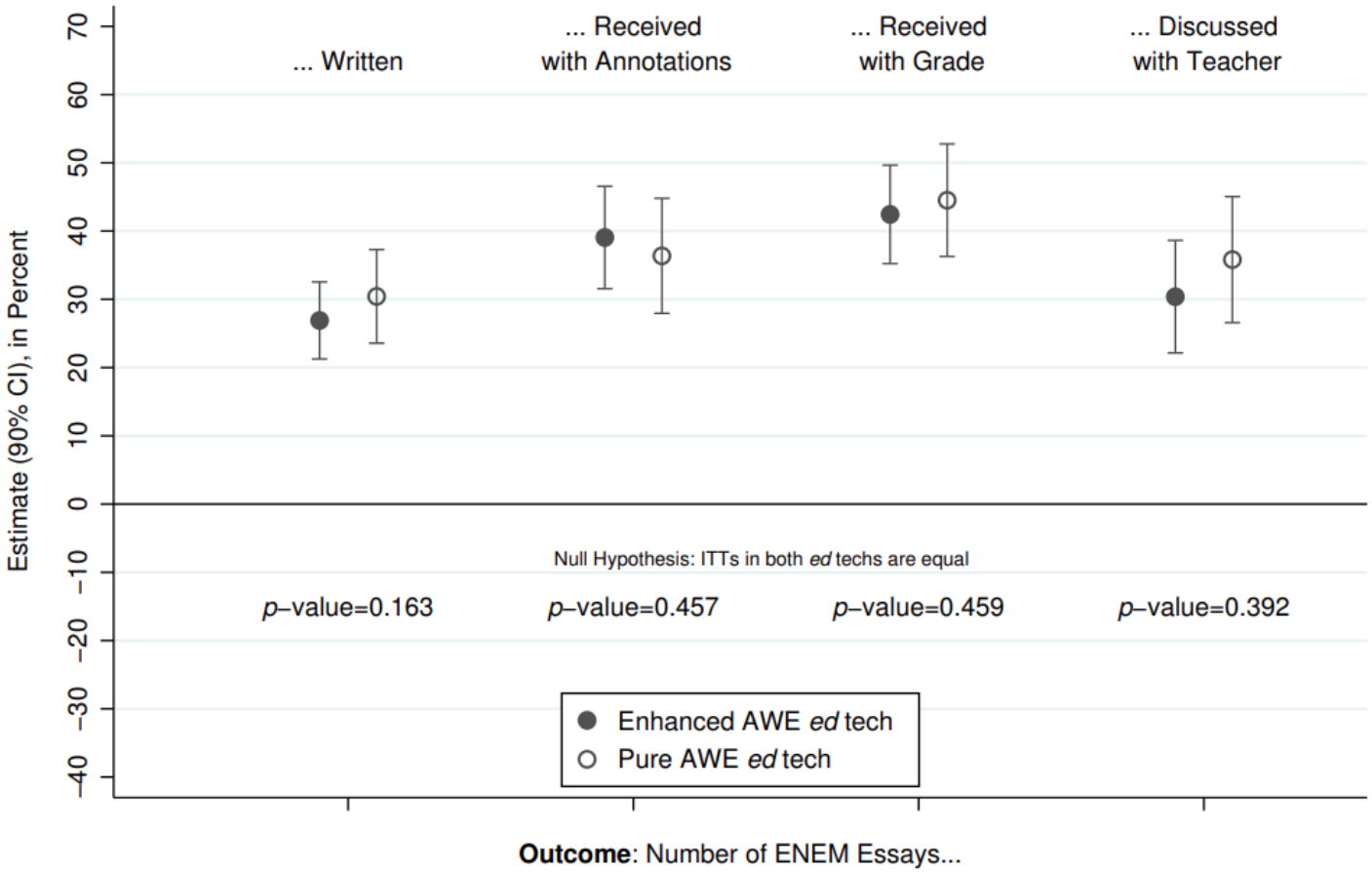


Figure: *ed* techs Had **Very Similar Impacts on Training and Feedback**

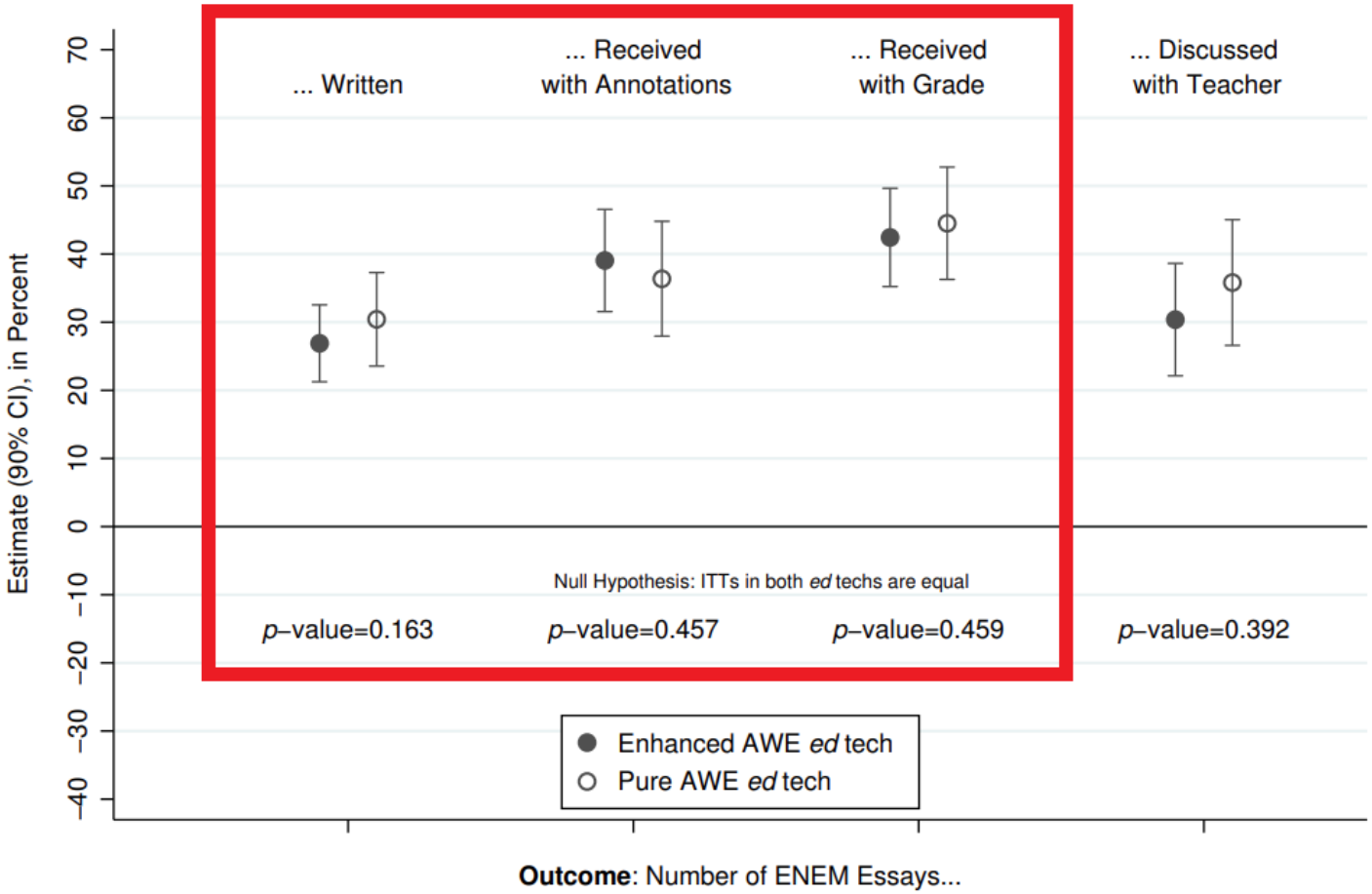


Figure: *ed* techs Induced **Very Similar Shifts to Nonroutine Tasks That Supported the Individualization of Pedagogy**

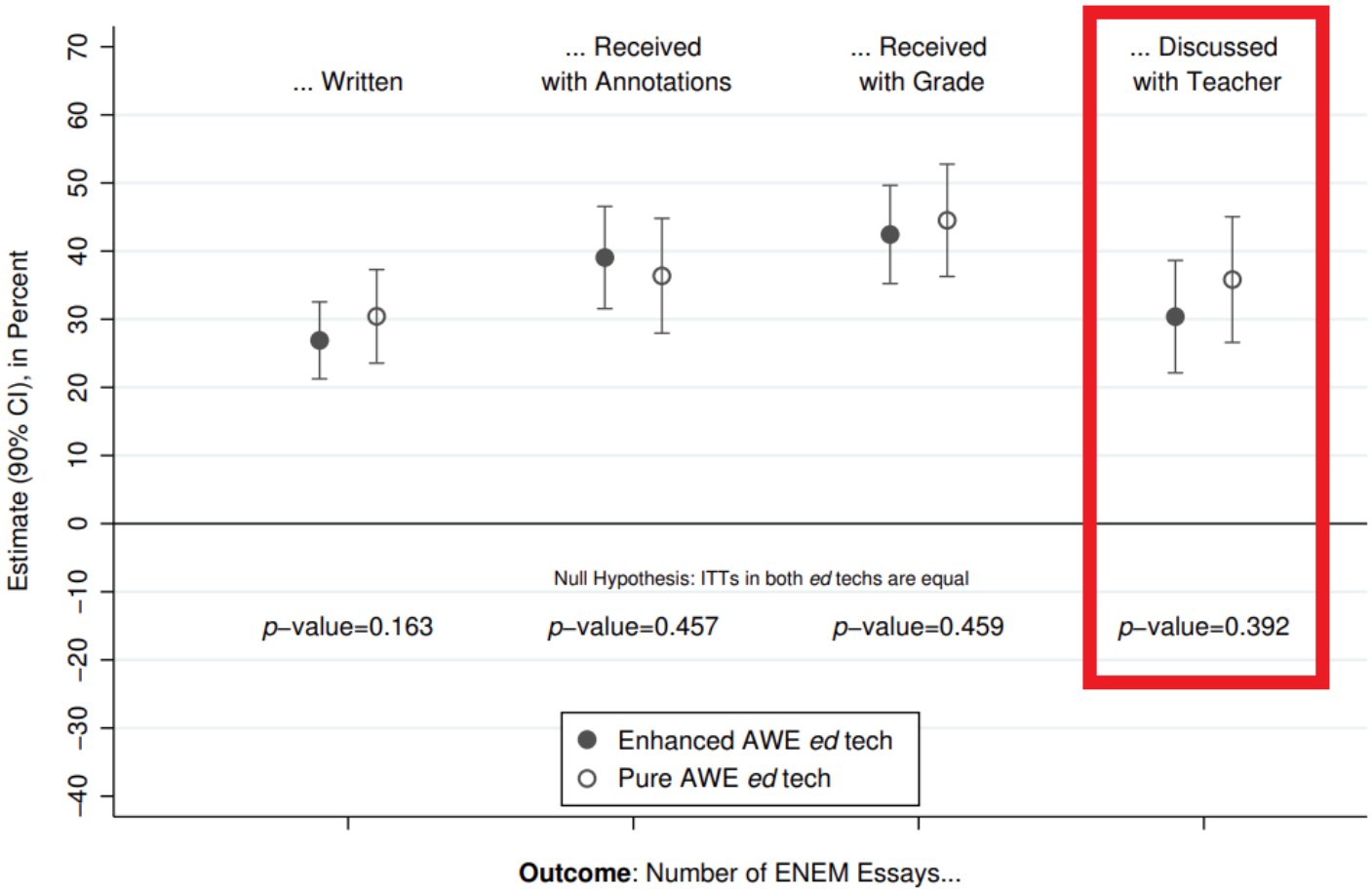


Figure: *ed* techs **Positively Impacted the Quality of Feedback**

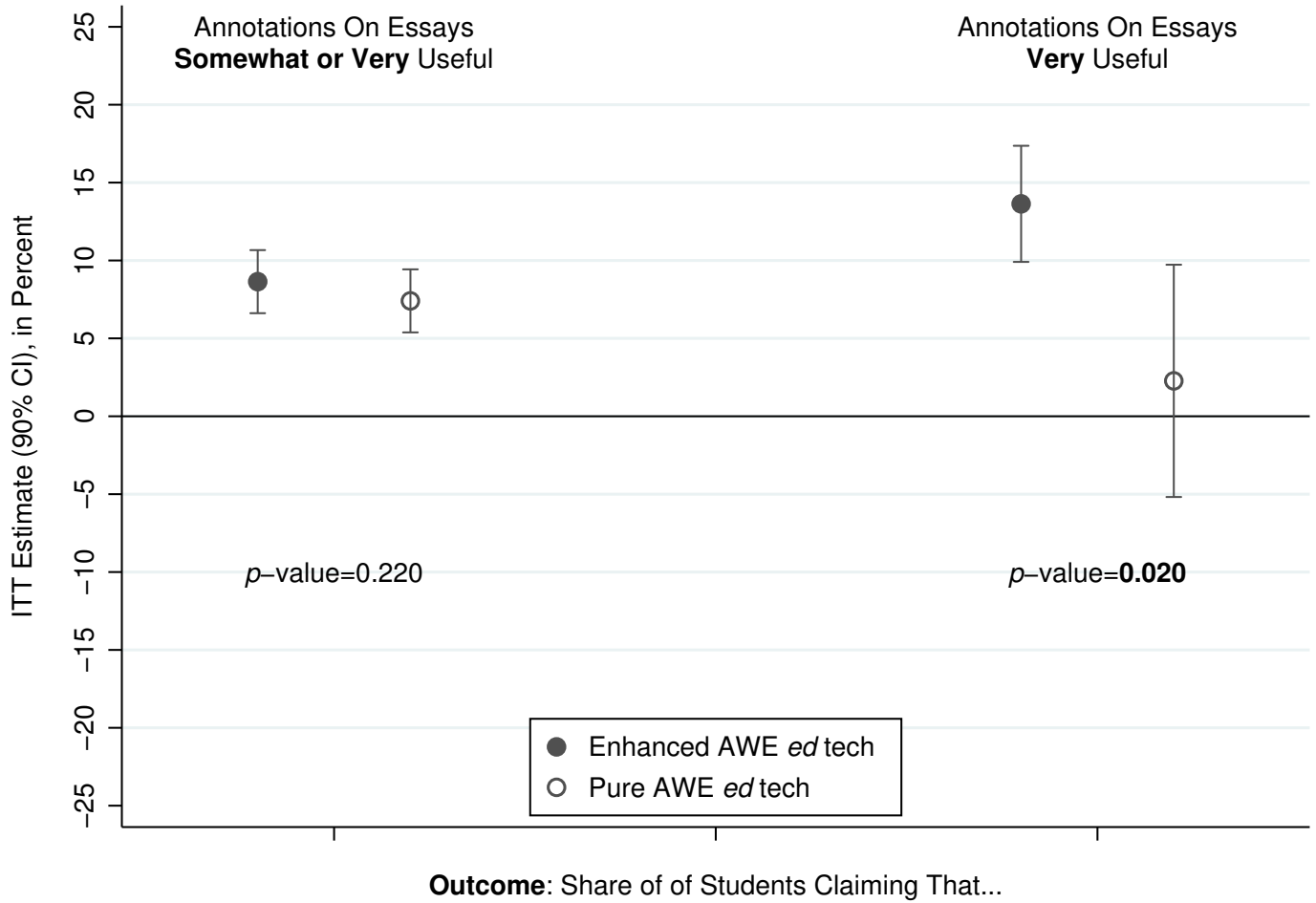
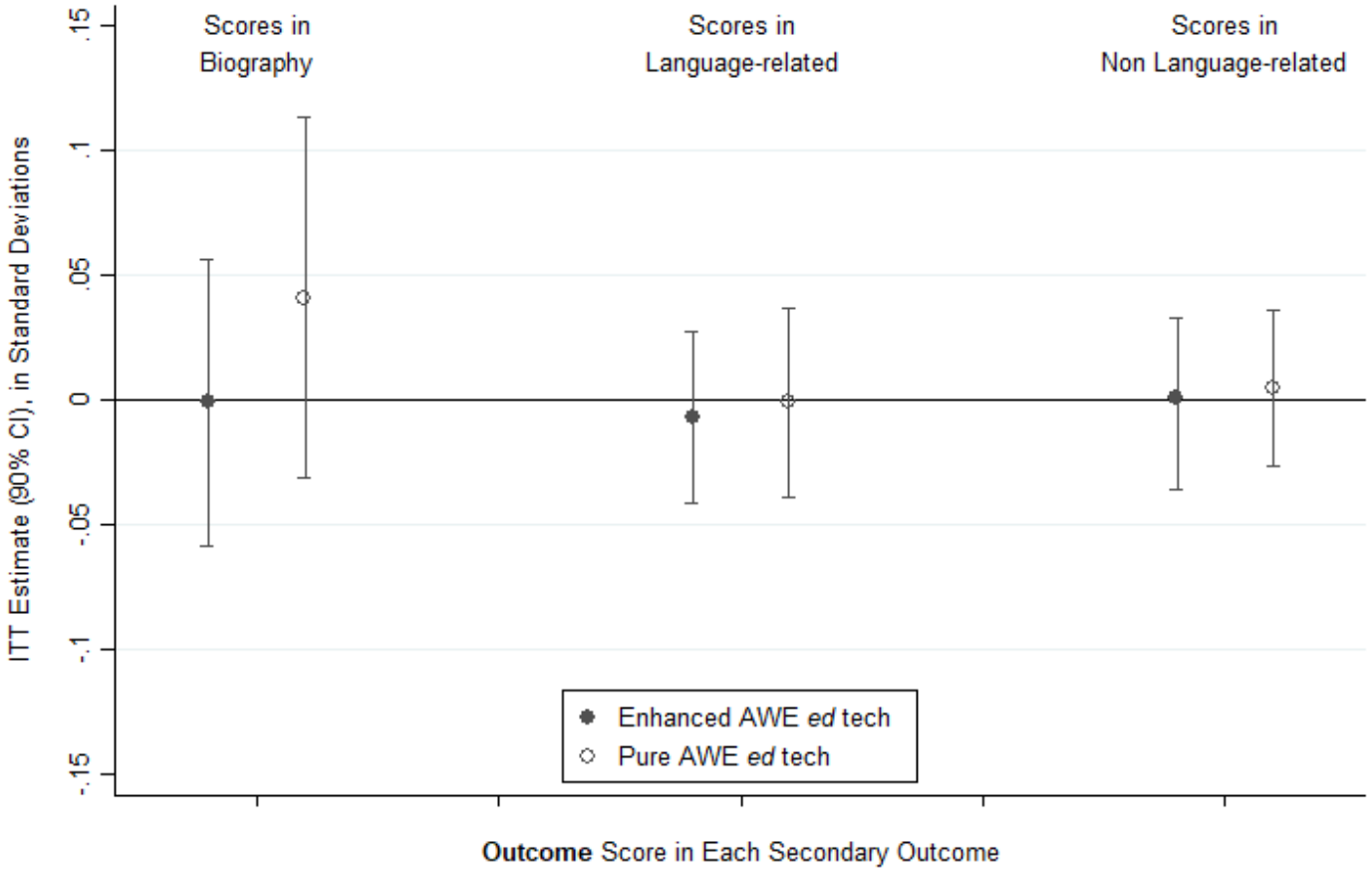


Figure: **No Evidence of Adverse Effects or Topic Complementarity**



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- Despite improvements in perceived quality, additional inputs from **human graders** did not improve effectiveness.
- Positive effects even in skills AI arguably falls short in evaluating.
- Suggestive evidence of complementarity: teachers' tasks shift toward **nonroutine** tasks (interpretation of essays and personal interaction about writing quality).

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3. Pure AWE $\iff$ Enhanced AWE:
   - **no added value** of human graders, which are costly
   - question of **perfect task emulation** (or substitutability) bypasses the **complementarities** based on expected comparative advantages between AI and human labor

Luckin et al, 2016, Intelligence unleashed: An Argument for AI in education.

"*AI-powered tools will serve as a catalyst for the transformation of the role of the teacher* [...] *allow*[*ing*] *teachers to devote more of their energies to the creative and very human acts that provide the ingenuity and empathy to take learning to the next level*."

Thank You!