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EVIDENCE-GATED MANAGEMENT OF PROJECT-BASED ENGINEERING LEARNING

Committee of Education, Learning and Management (08ELM)

International Organization on Technical and Physical Problems of Engineering (IOTPE)

Research motivation and objective

- Milestone-only supervision may identify learning problems too late.

- Project evidence can reveal competency gaps, schedule slips, repeated rework and uneven responsibility.

- Question: When is the evidence sufficient to justify a targeted instructor intervention?

- Contribution: a transparent evidence-gated management procedure, evaluated by simulation.

Five complementary evidence channels

Channel	What it reveals
Competency	Can assigned students explain and perform the technical work?
Schedule	Repeated deviations from planned progress
Rework	Recurring technical defects and unnecessary repetition
Workload	Persistent imbalance in task ownership and effort
Dependency	Single-person concentration of critical knowledge

Evidence-gated management cycle

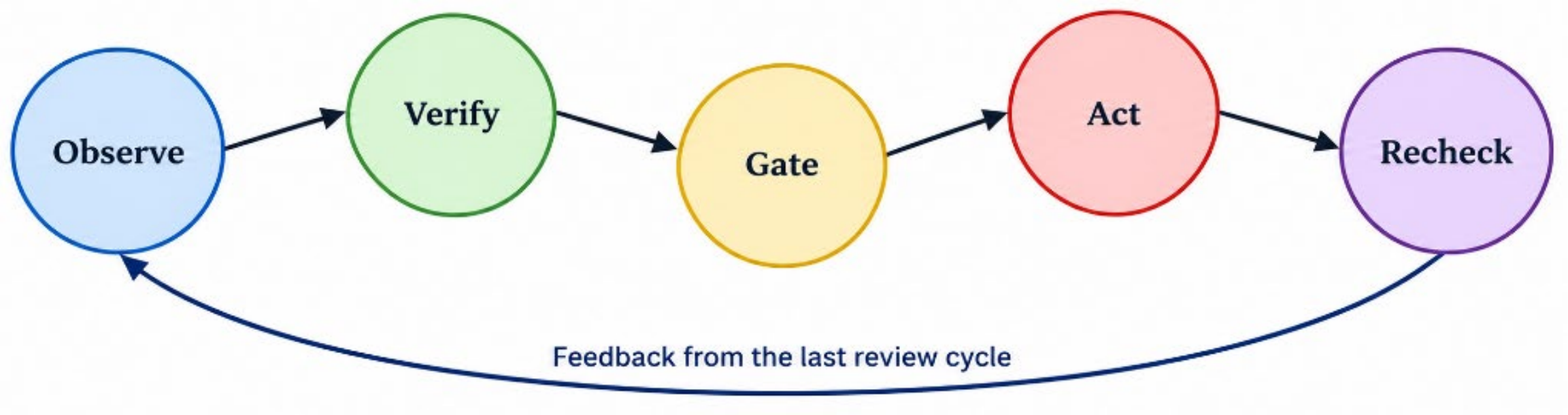


Figure 1 of the paper: observe → verify → gate → act → recheck.

A decision is recorded only after technical evidence is verified against the gate criteria.

Decision levels and instructor responses

Level	Evidence pattern	Action
G0	No persistent warning	Continue; review next week
G1	One persistent warning	Focused support and follow-up
G2	Two related warnings	Technical or planning intervention
G3	Repeated multi-channel risk	Replan scope, roles or sequence

The rule distinguishes a temporary fluctuation from persistent or coupled problems.

Numerical case study

- 12-week multidisciplinary engineering project with six teams.
- Four milestones: weeks 3, 6, 9 and 12.
- Weekly evidence review across five normalized indicators.
- 800 modeled runs per supervision policy, with matching random conditions.
- Results are simulation outputs—not observed improvements among enrolled students.

Three supervision policies

Policy	When it reacts
Milestone-only	When a formal deliverable is late or rejected
Risk-triggered	When any one risk threshold is exceeded
Evidence-gated	When one warning persists or two related warnings coincide

The evidence gate aims to reduce late interventions without reacting to every noisy warning.

Measured outputs in the numerical study

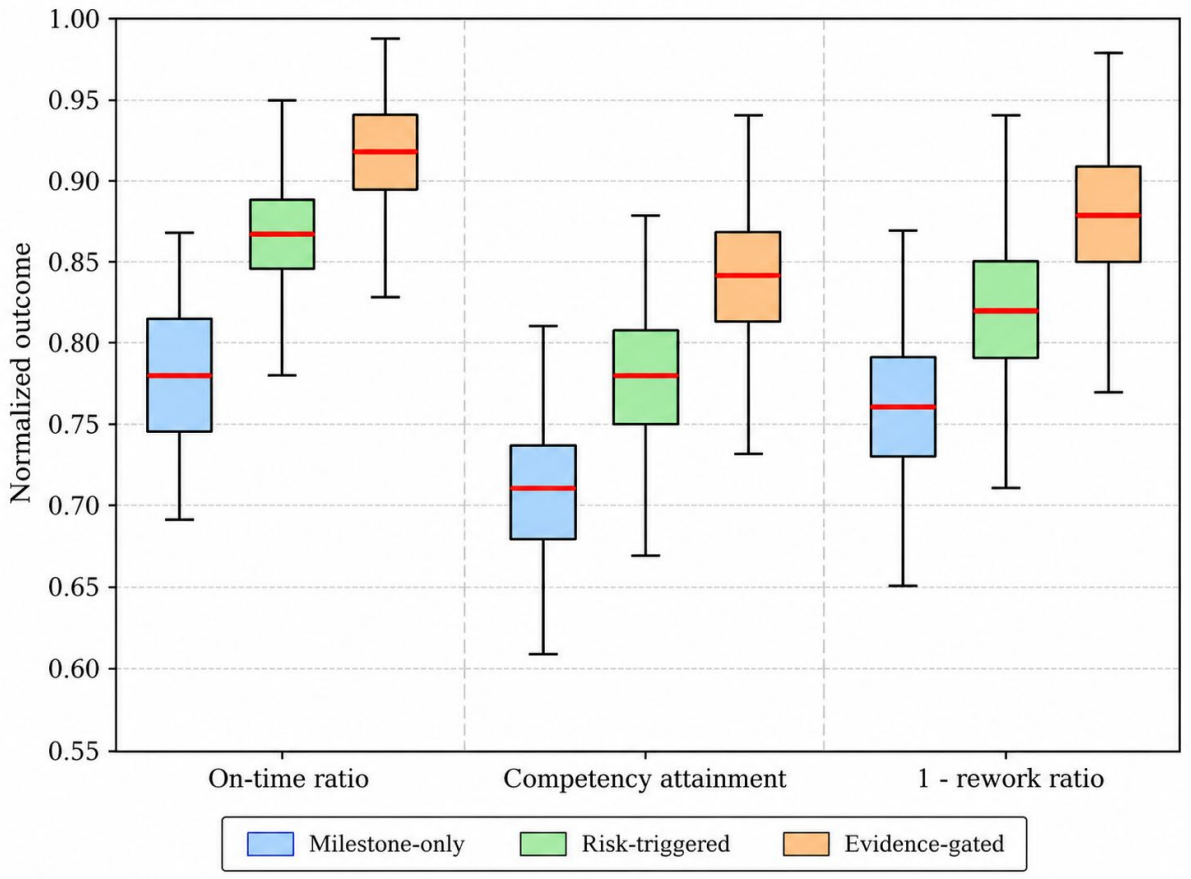
- On-time milestone ratio: proportion delivered in the scheduled week.
- Rework ratio: share of effort spent repeating unsuccessful technical work.
- Competency attainment: normalized simulated technical-check outcome.
- Late events: average milestone-related delays.
- Instructor intervention time is considered as a resource trade-off.

Main comparison: 800 modeled runs per policy

Policy	On-time	Rework	Competency	Late events
Milestone-only	0.780	0.234	0.706	5.38
Risk-triggered	0.866	0.176	0.777	3.70
Evidence-gated	0.918	0.122	0.842	2.45

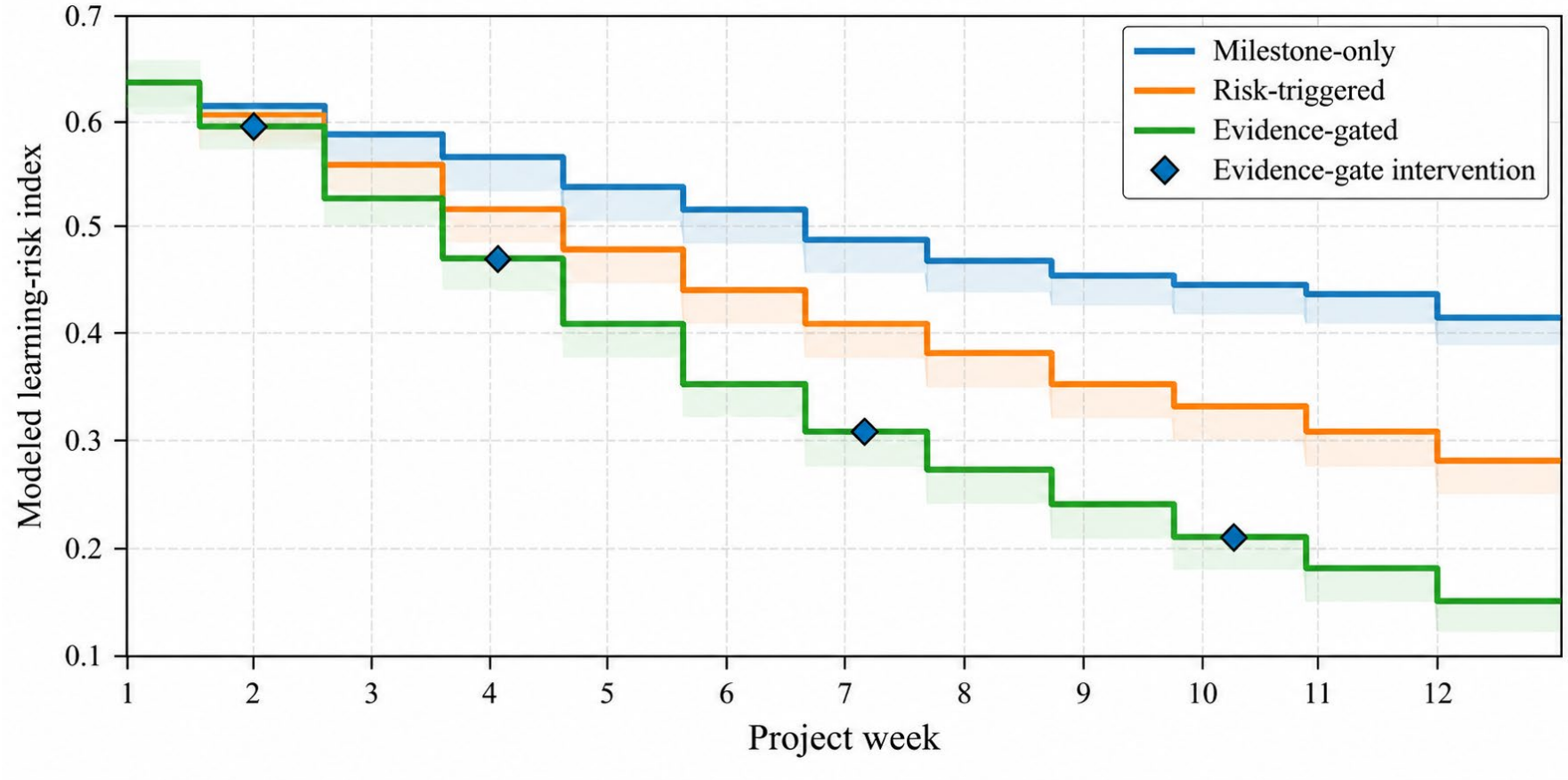
Evidence-gated supervision performed best on all four modeled outputs.

Distribution of simulated outcomes



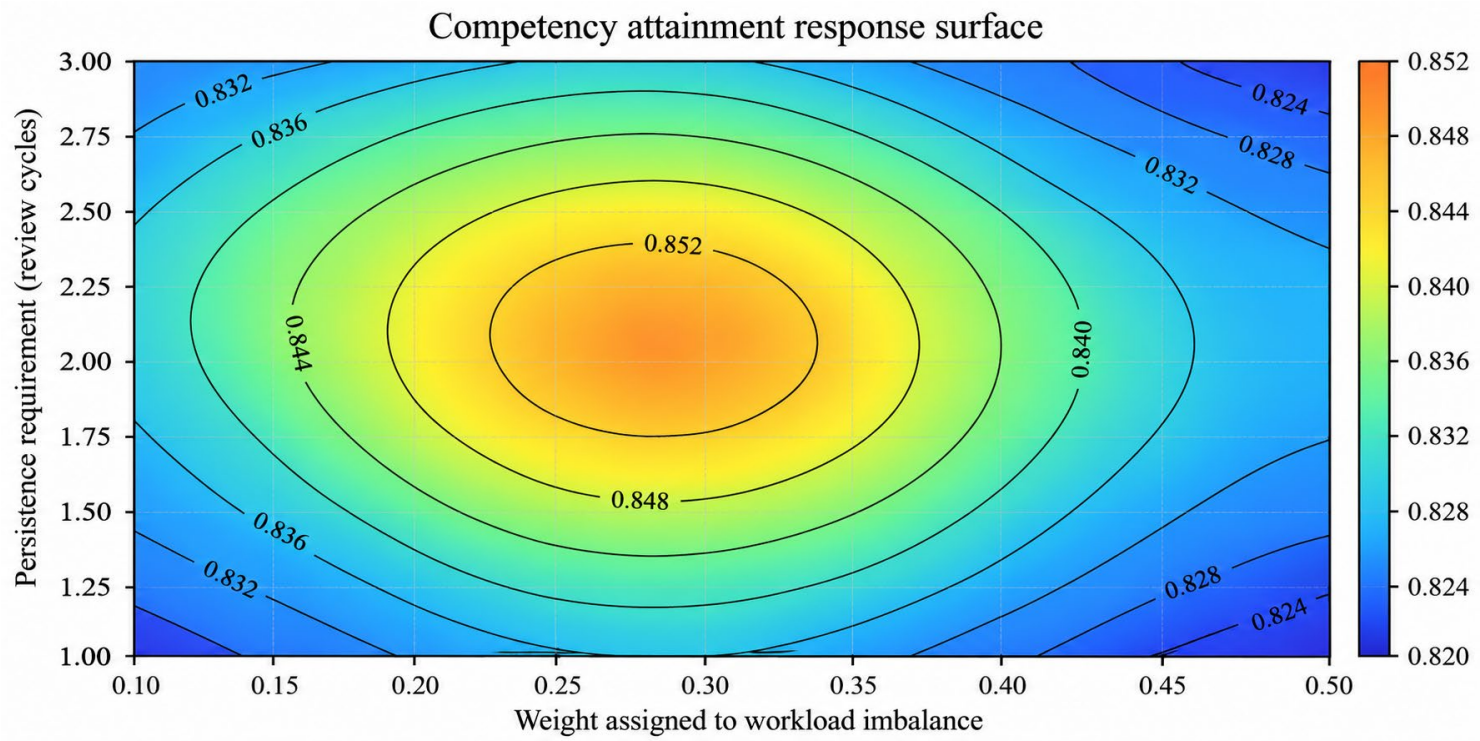
Paper Figure 2 — normalized outcome distributions for the three policies.

Timing matters: modeled learning-risk trajectory



Paper Figure 3 — changes in learning-risk index over 12 project weeks.

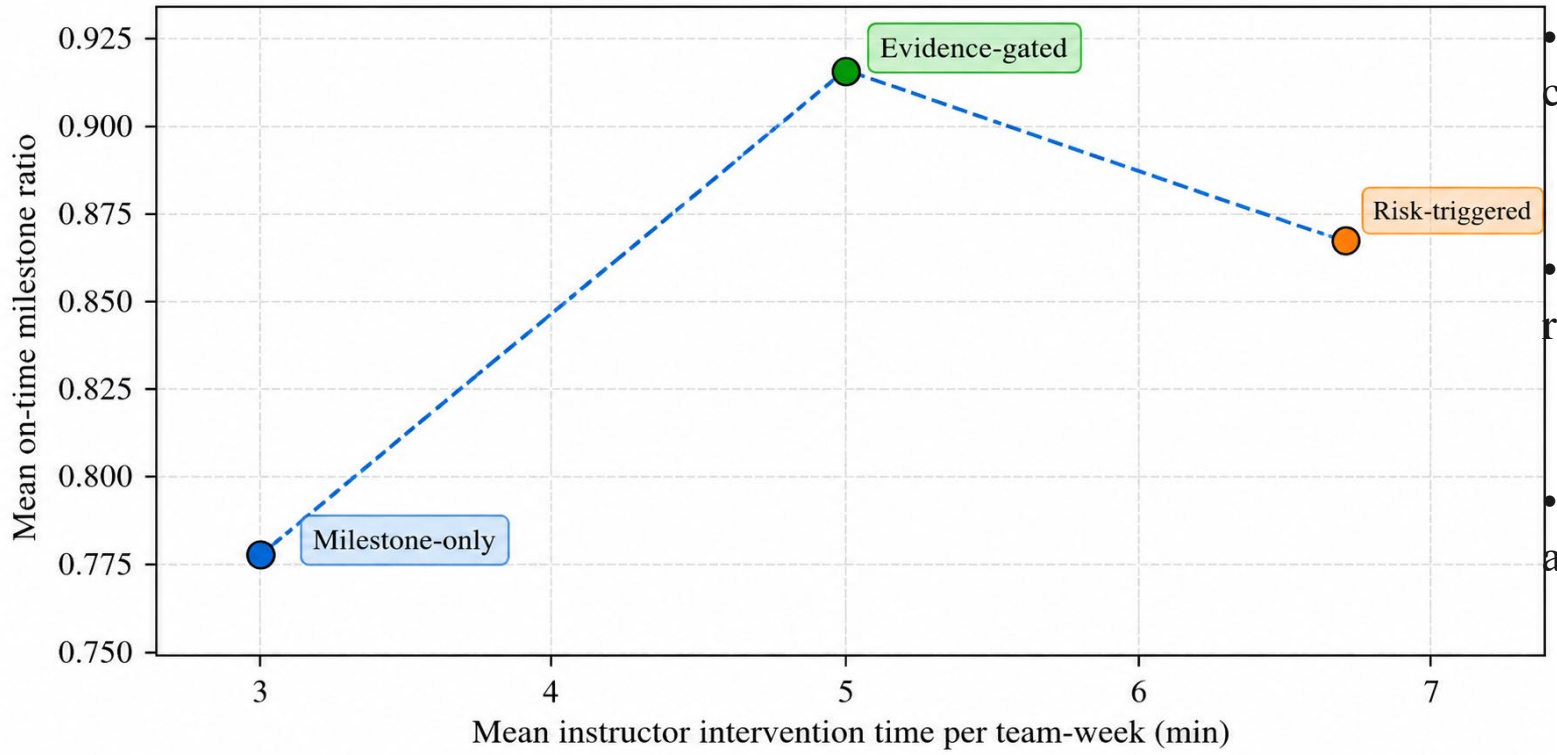
Sensitivity and robustness



- Qualitative advantage persists across tested warning-persistence rules.
- One-cycle checks are faster, but trigger more false alarms.
- Three-cycle persistence delays response.
- Two cycles balanced sensitivity and selectivity in the base case.

Paper Figure 4 — workload weighting and persistence settings.

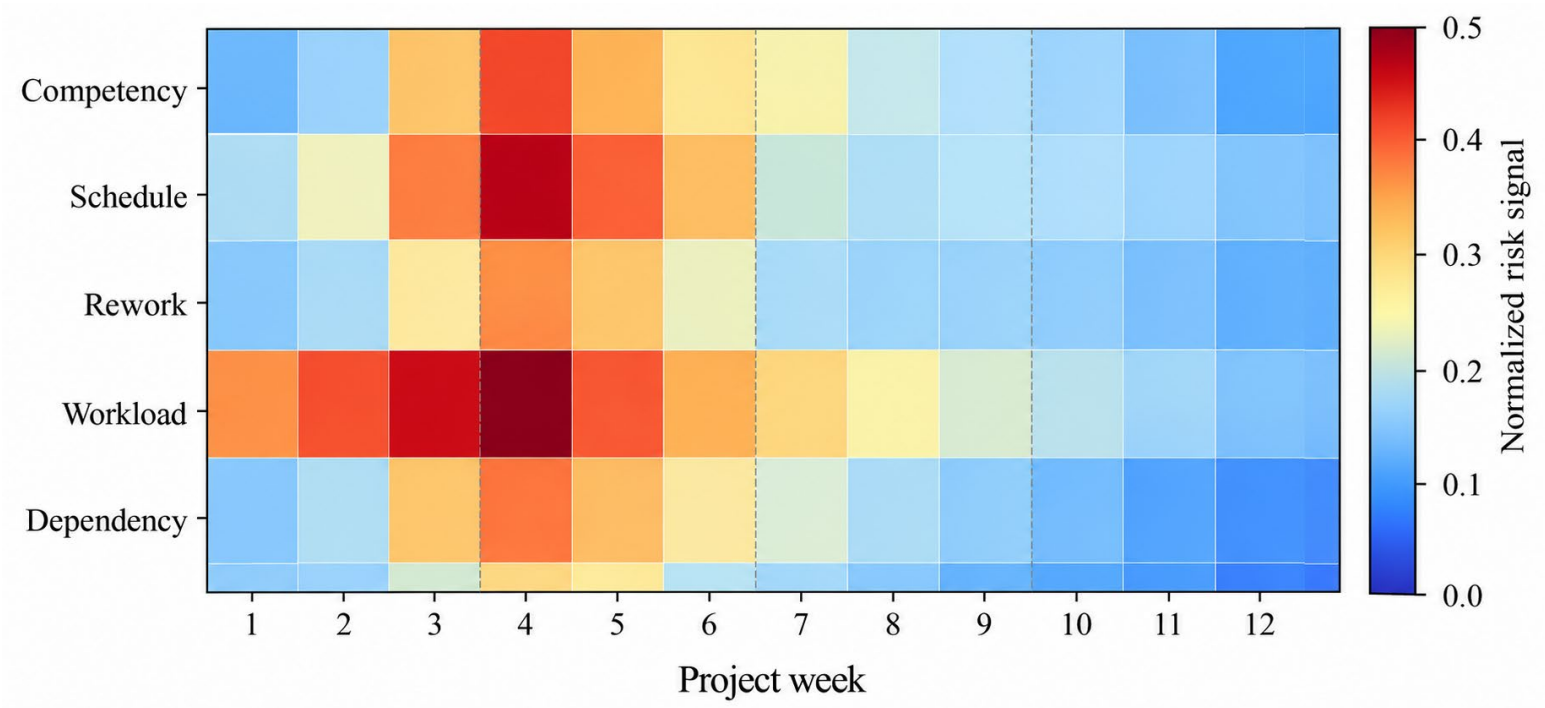
Instructor time versus performance



- Milestone-only: limited early contact, later recovery effort.
- Risk-triggered: more frequent reactions to warnings.
- Evidence-gated: targeted attention after evidence becomes credible.

Paper Figure 5 — modeled resource–performance relationship.

A practical evidence dashboard



- Maintain a short weekly record from normal course work.
- Attach the actual calculation, note or task history behind each warning.
- Avoid hidden monitoring and permanent student labels.

Paper Figure 6 — example team evidence matrix, with stronger warnings in darker cells.

Limitations and prospective validation

- Outcomes come from a controlled simulation, not a trial with students.
- Evidence thresholds and intervention effects were modeling assumptions.
- Future study: compare policies across real engineering modules with common instruction.
- Record competency checks, rework, punctuality, workload and feedback consistency.
- Use proportionate, transparent data collection with student awareness.

Conclusions

- Evidence gates connect technical observations to explicit instructor decisions.
- Persistence and coupling rules help distinguish credible risks from transient noise.
- Simulation results: on-time ratio 0.918, rework ratio 0.122, competency attainment 0.842.
- The framework supports—not replaces—instructor engineering judgment.
- Real-course validation is required before claiming an educational benefit.