

Improving Embedded Software Development Courses: A Student Attentive Data-Driven Approach^[1]

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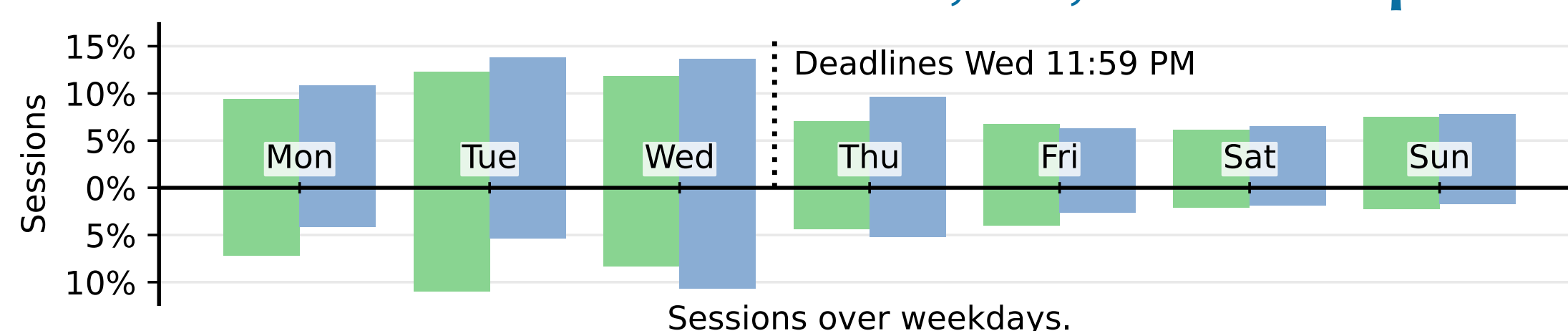
Abstract

Learning analytics can provide valuable insight to improve the learning experience for students. We have been successfully using the ATTEST test system in our Real-Time Operating Systems course for two semesters. Besides the direct advantage of providing low-latency feedback to students, analysis of usage data provides the foundation for adaptation decisions to improve the course in future semesters. This poster summarizes the key outcomes of the 11 questions addressed in the accompanying paper. These include the preferred working day and time to schedule Q&A hours and the number of passed test cases as the deadline approaches. Moreover, a technical analysis shows that the test system response time is sufficiently short despite the constraint of testing on the actual target MSP430 microcontroller. Thus, students can receive multiple feedback iterations within an average working session length without interrupting their workflow.

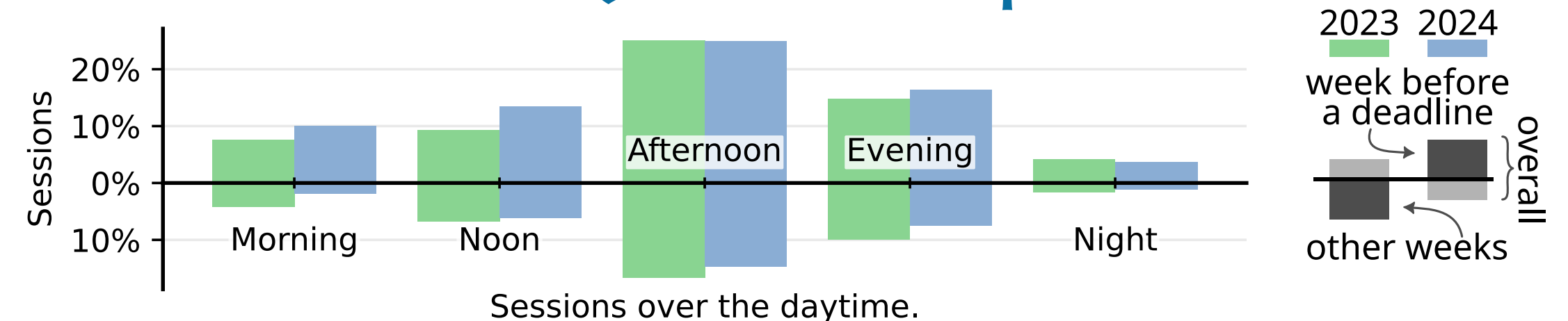
RTOS Laboratory

- Embedded Real-Time Operating System (RTOS) for MSP430
- Anonymized data from 2 semesters with identical modalities
 - 2023 : 47 participants, 42 active students
 - 2024 : 35 participants, 25 active students
- 6 exercises that depend on each other: build RTOS
- ATTEST^[2] Automated test system for low-latency feedback
 - test suite with approx. 57 test cases
 - executed on actual embedded target device
 - feedback via Markdown reports in Git

When are students most active, i.e., what is a preferable time to schedule a Q&A hour or open labs?

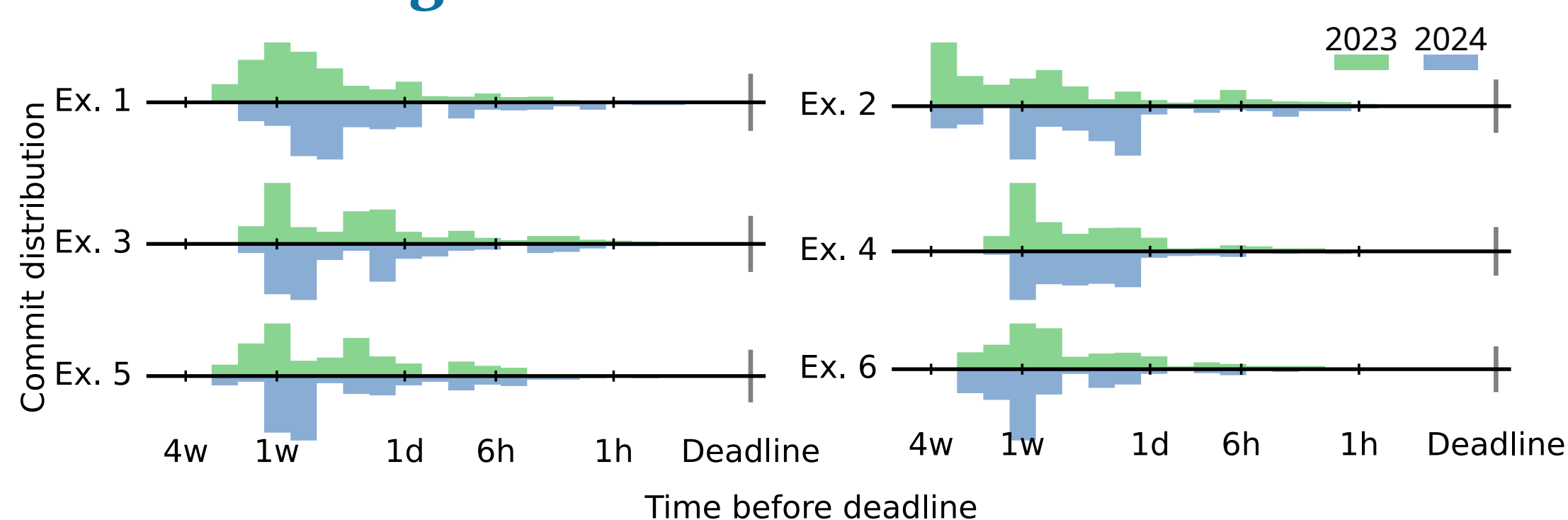


Working Session A set of consecutive commits, such that the delta time between commits is at most 90 minutes, to estimate working time without the noise of single-commit fixes. The initial session length for the first commit is 1 hour.
→ Upcoming deadline strongly influences working behavior.



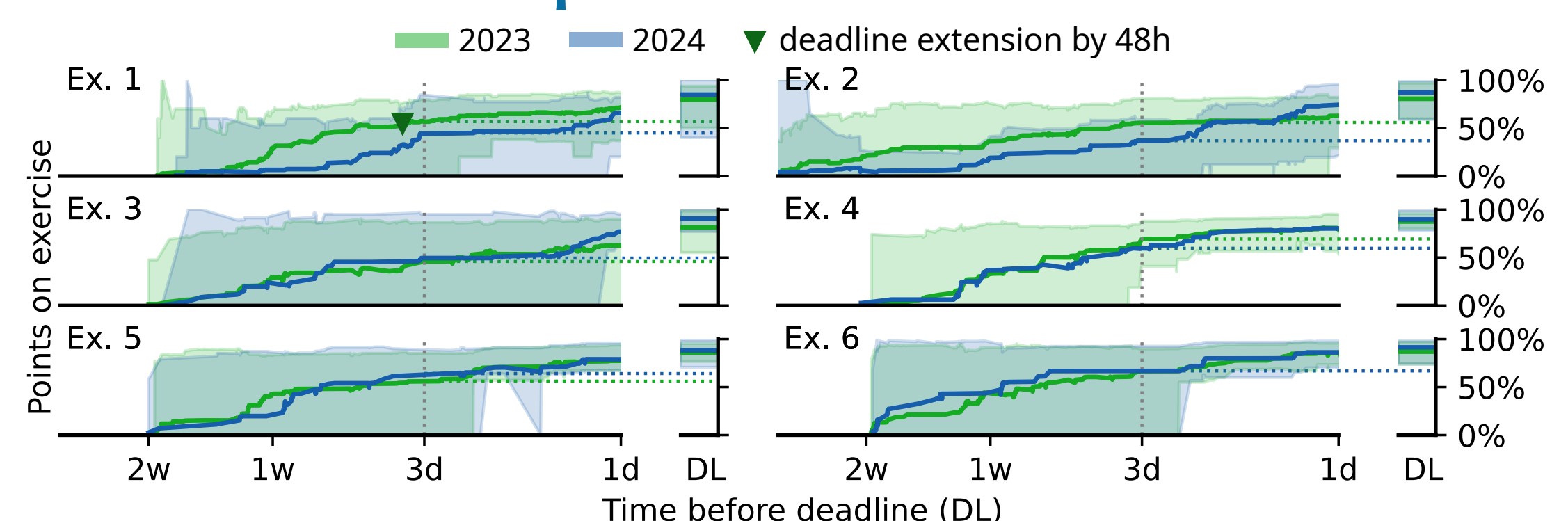
While there are just a few sessions in the morning and noon more than 7 days before a deadline, these categories are both more pronounced in the week before a deadline.
→ High correlation between both semesters.
→ Significantly more sessions in pre-deadline weeks.

Is there enough time until the deadlines?



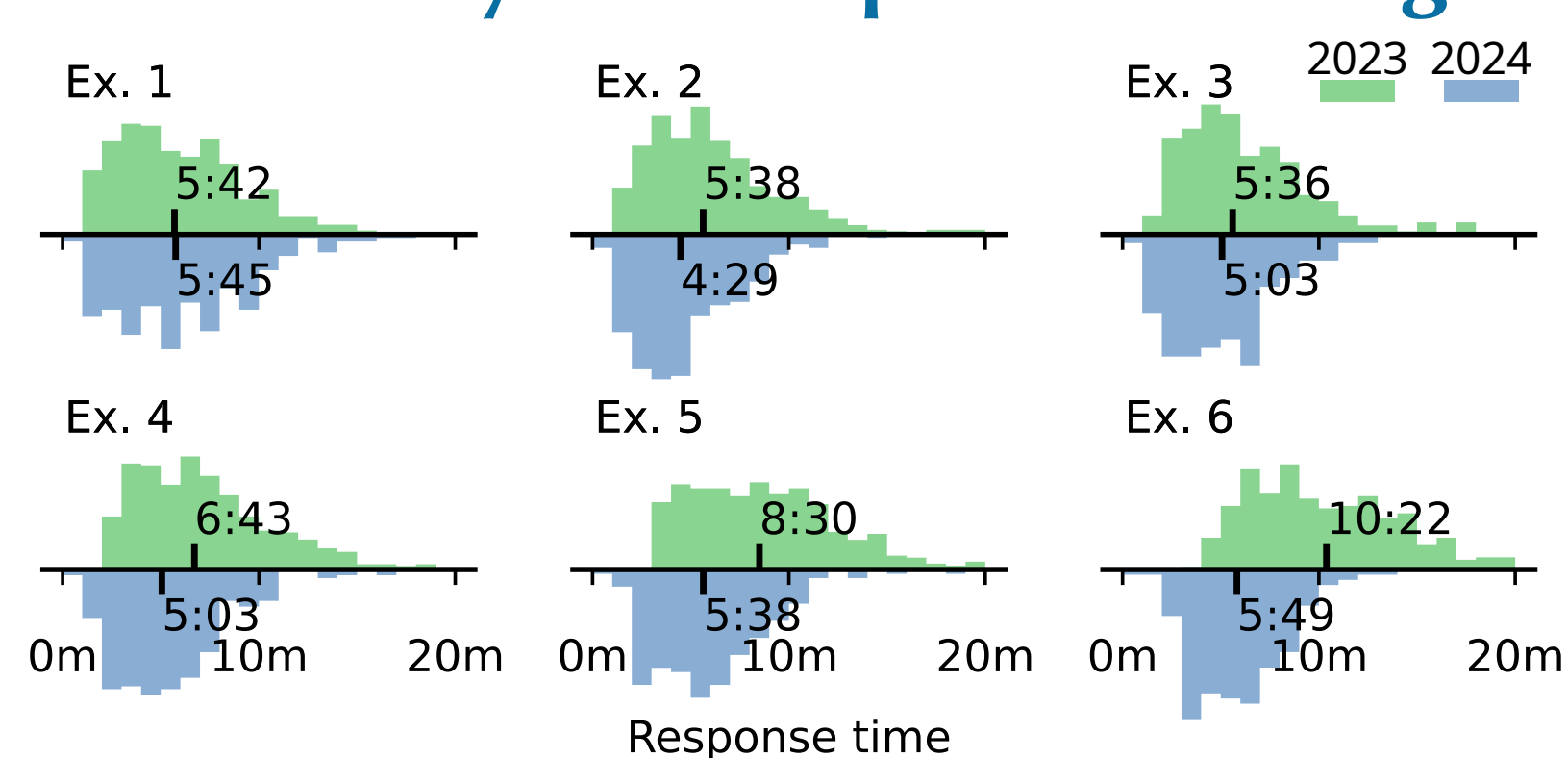
→ Majority of work done between one week and one day before a deadline.
→ Little last-minute activity.

How does exercise performance evolve?



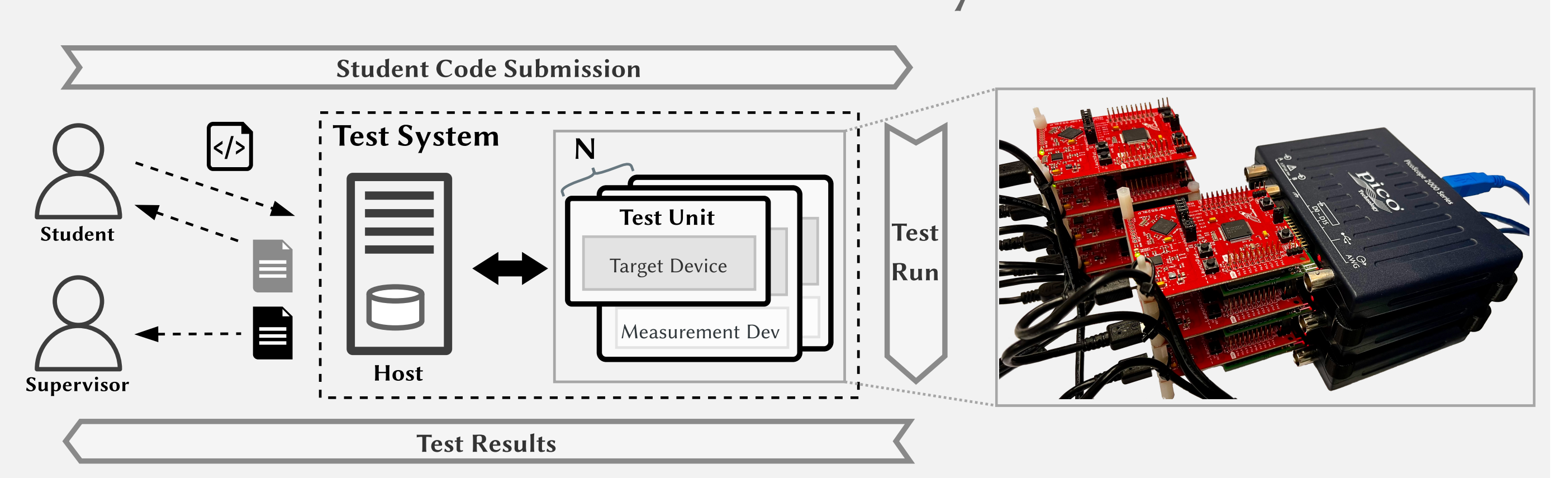
→ Changes in the last 3 days lead to a noticeable increase in passed test cases.
→ Motivate students to start early to have sufficient time for fixes.

Is the test system responsive enough?

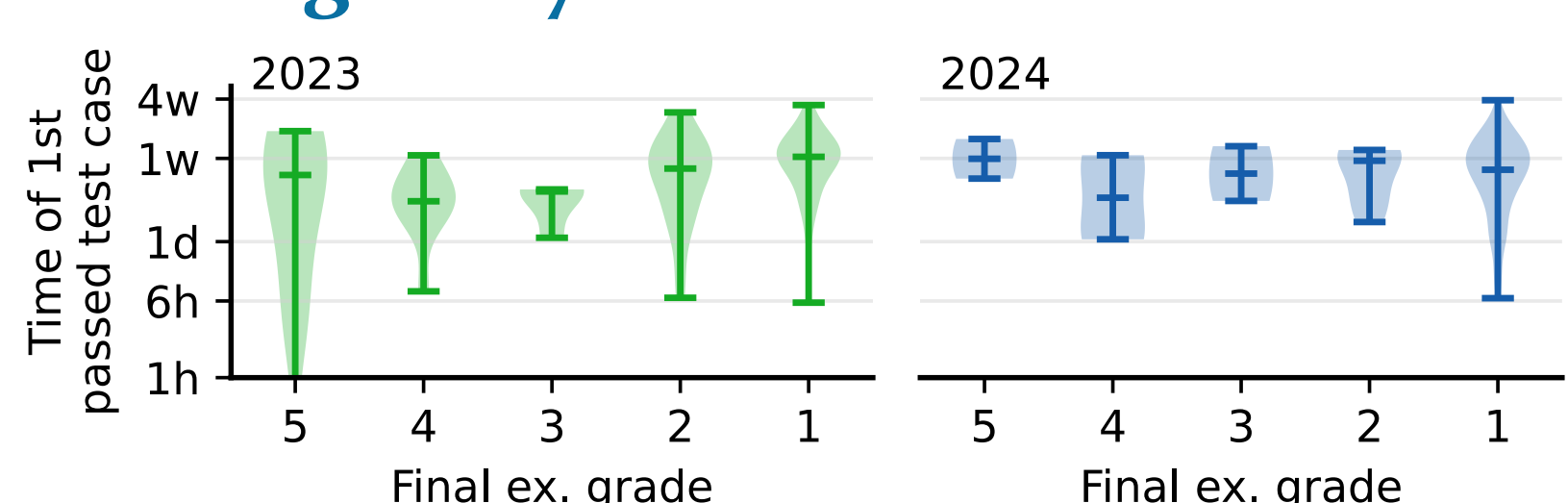


→ Multiple feedback iterations within a typical session possible.

Overview of the Utilized ATTEST Test System

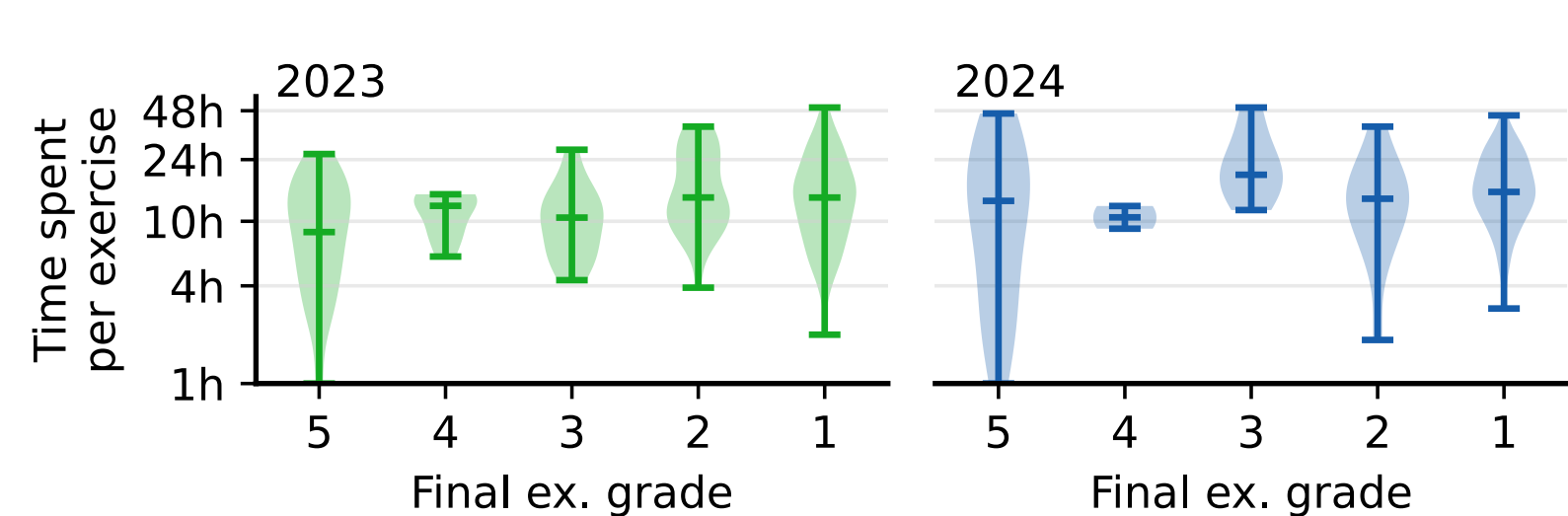


Starting Early



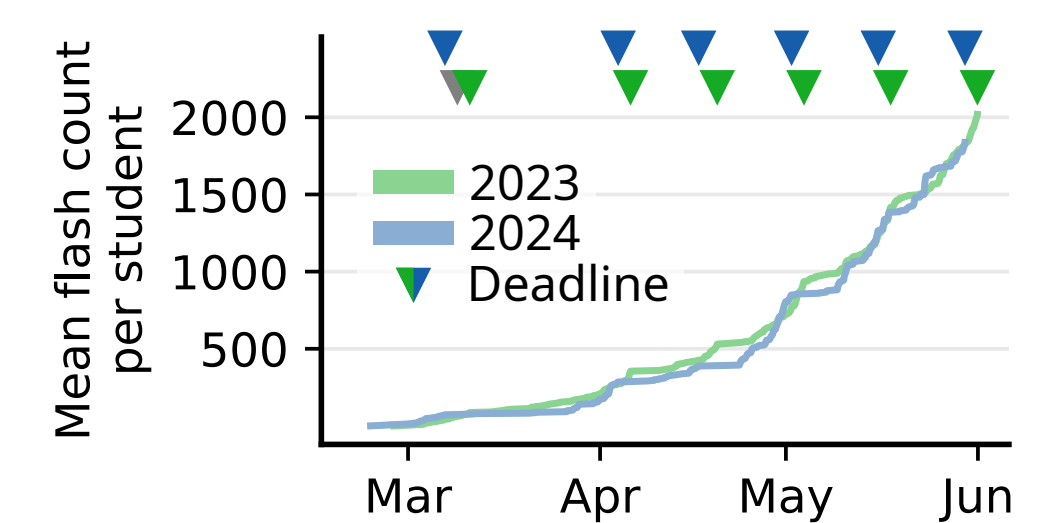
How does the starting time influence the exercise success?
→ Starting time has little correlation with exercise grades.

Motivation & Dedication

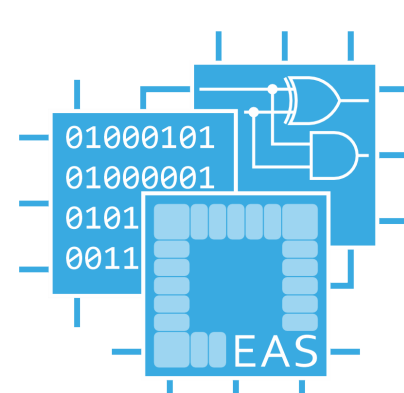


Does motivation and dedication in form of spent time pay off?
→ Little correlation between time spent on exercises and grades.

Flash Count



→ MSP430 lifetime: ~2% wear per student and semester expected.



References

- [1] M. Kissich, K. Weinbauer, and M. Baunach. 2025. Improving Embedded Software Development Courses: A Student Attentive Data-Driven Approach. 6th European Conf. on Software Engineering Education
- [2] M. Kissich, K. Weinbauer, and M. Baunach. 2023. ATTEST: Automated and Thorough Testing of Embedded Software in Teaching. 5th European Conf. on Software Engineering Education



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