L@S'18, June 26–28, 2018, London, UK

# **Elicast**: Embedding Interactive Exercises in Instructional Programming Screencasts


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|---|---|
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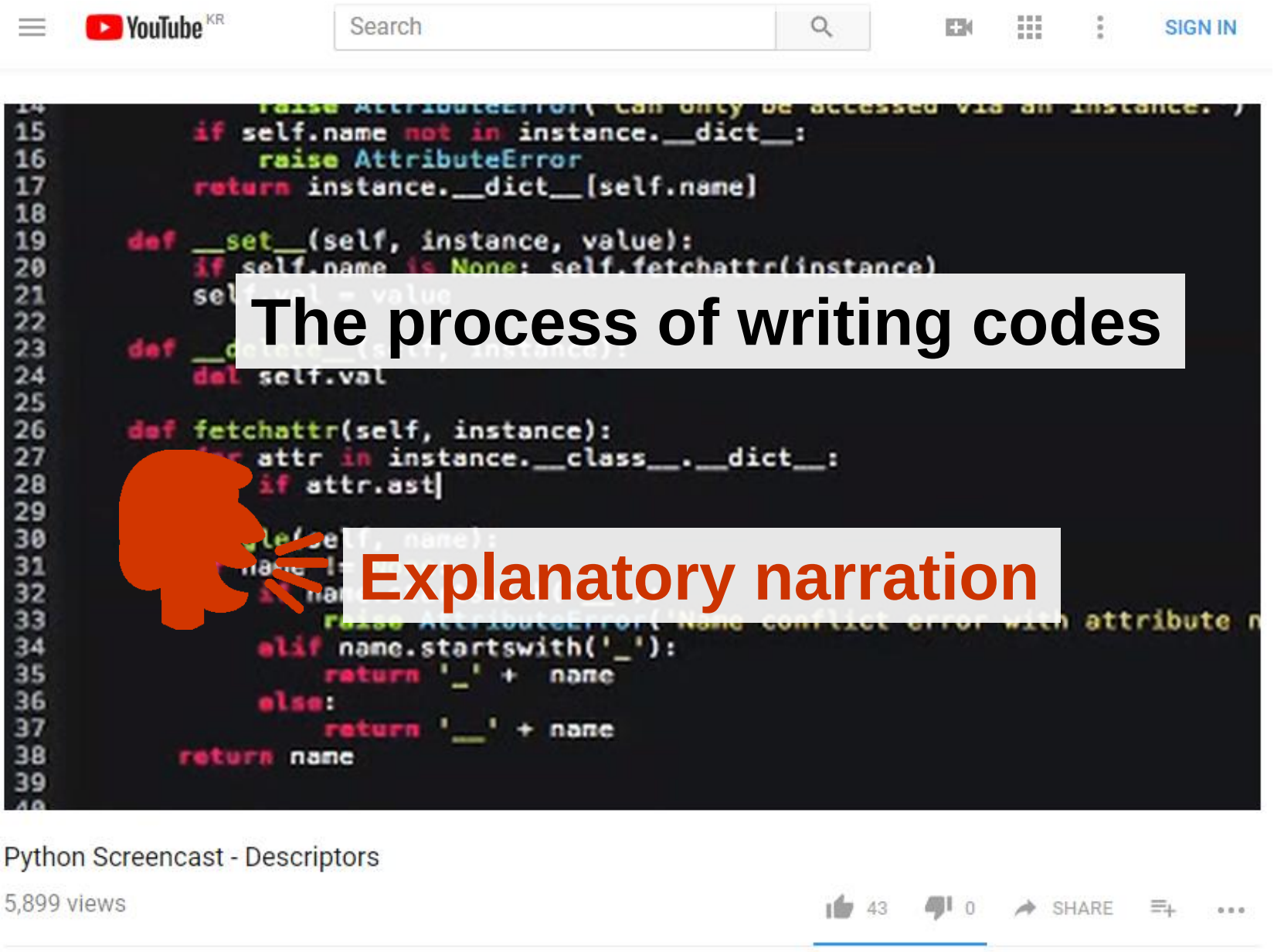
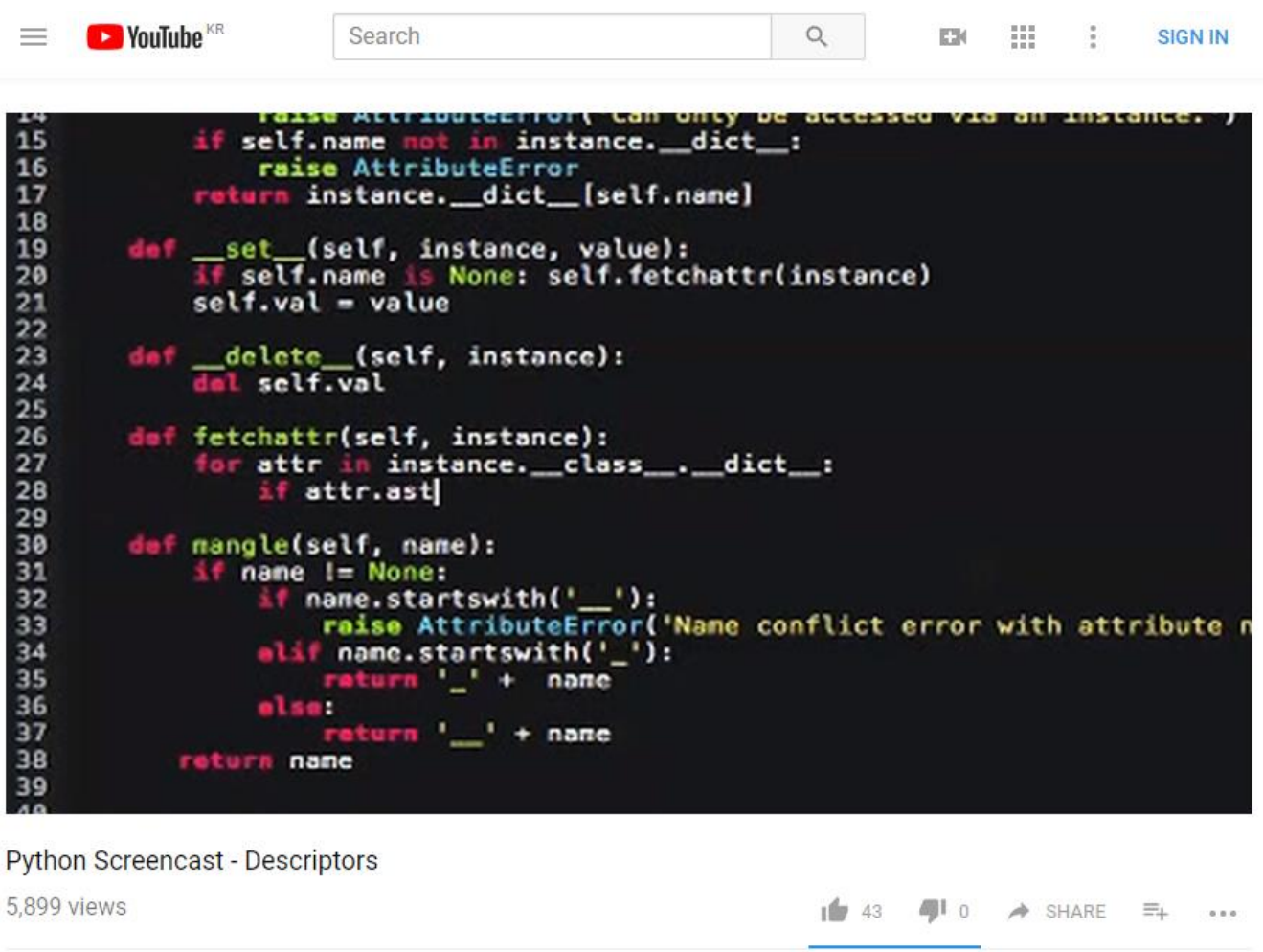
# Instructional Programming Screencast

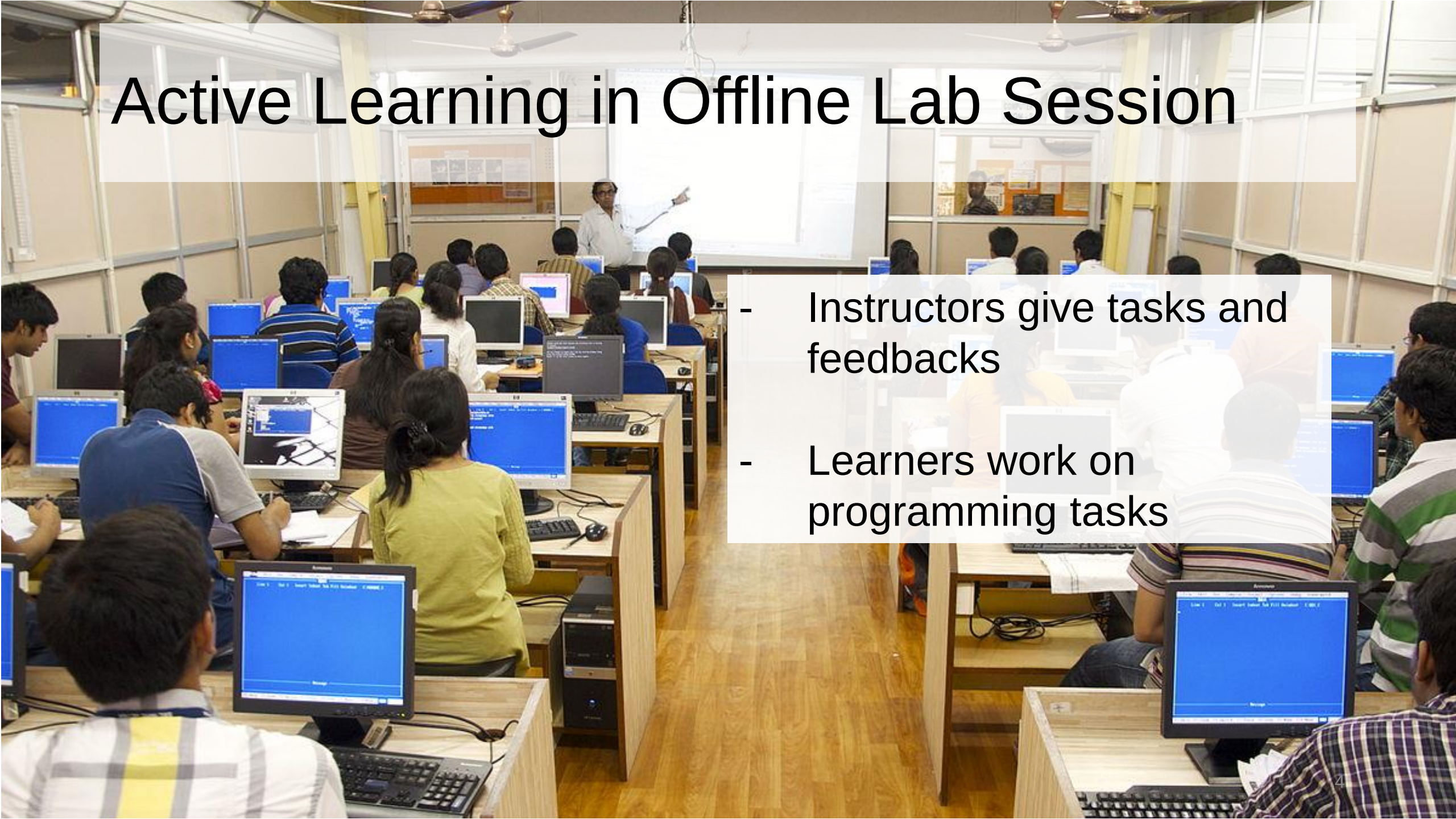





- Limited support for interaction with the content
- Separated experience between learn and practice

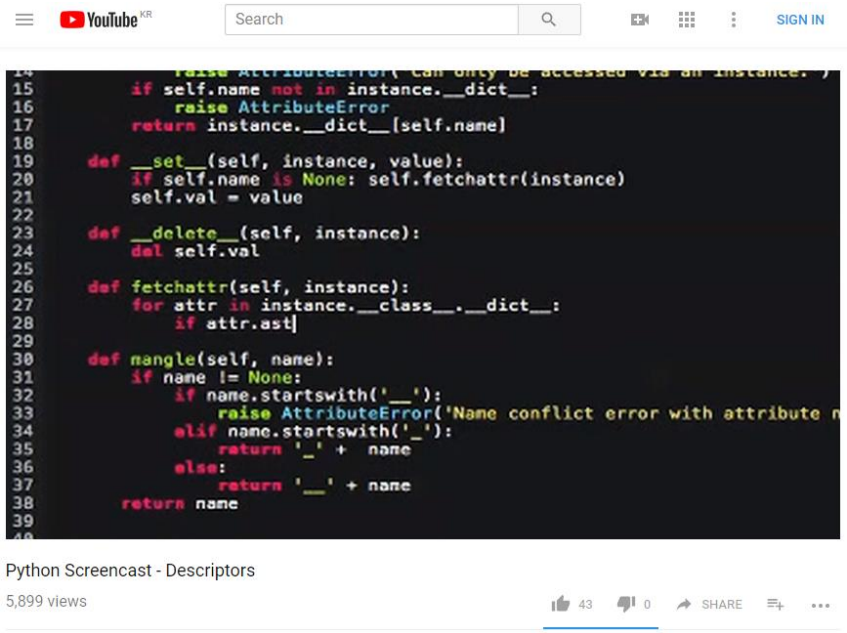
# Lack of Support for Active Learning

# Active Learning in Offline Lab Session



- Instructors give tasks and feedbacks
- Learners work on programming tasks

# Promoting Active Learning in Instructional Programming Screencast




> Demonstration of the process of writing code

> Hands-on programming experience

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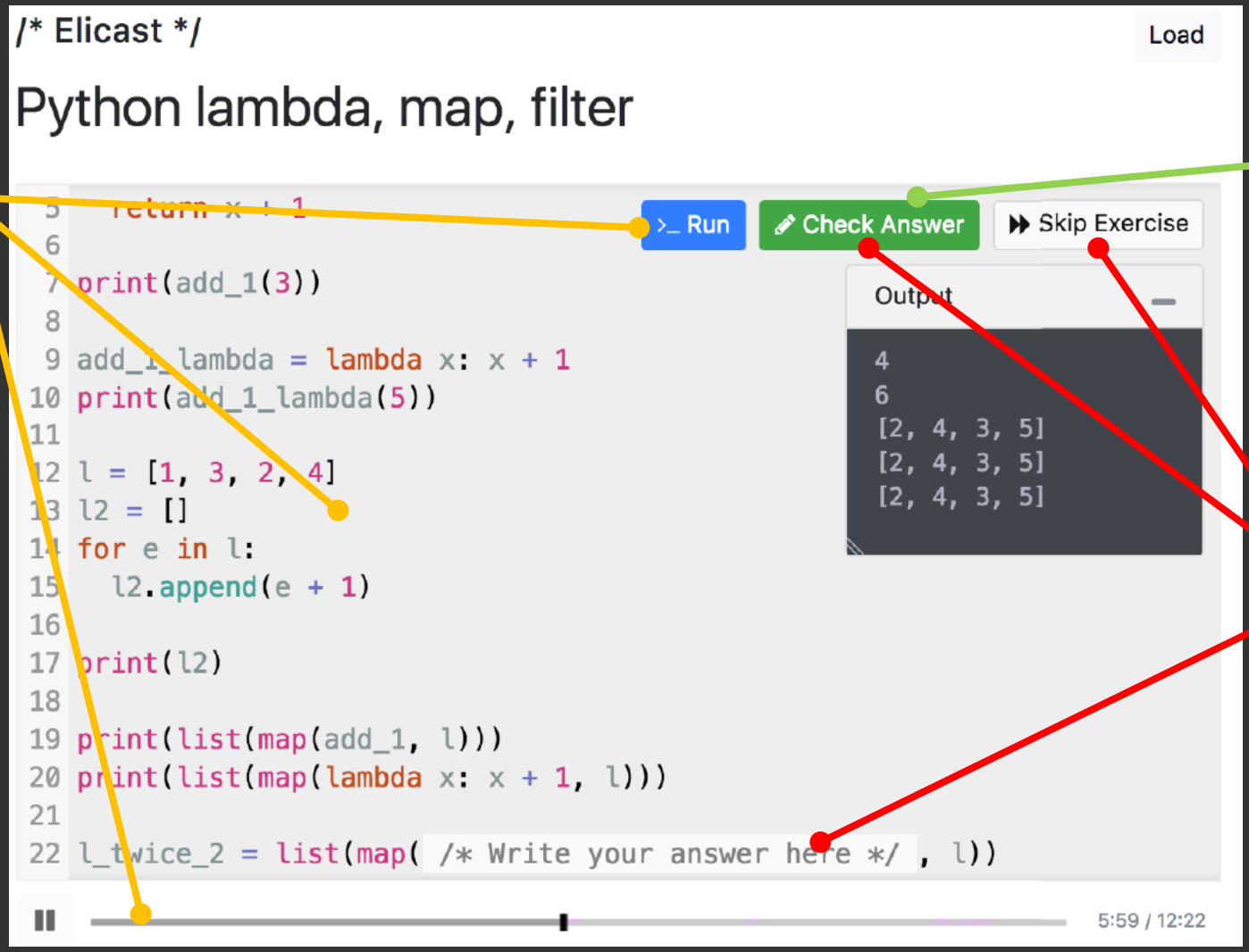
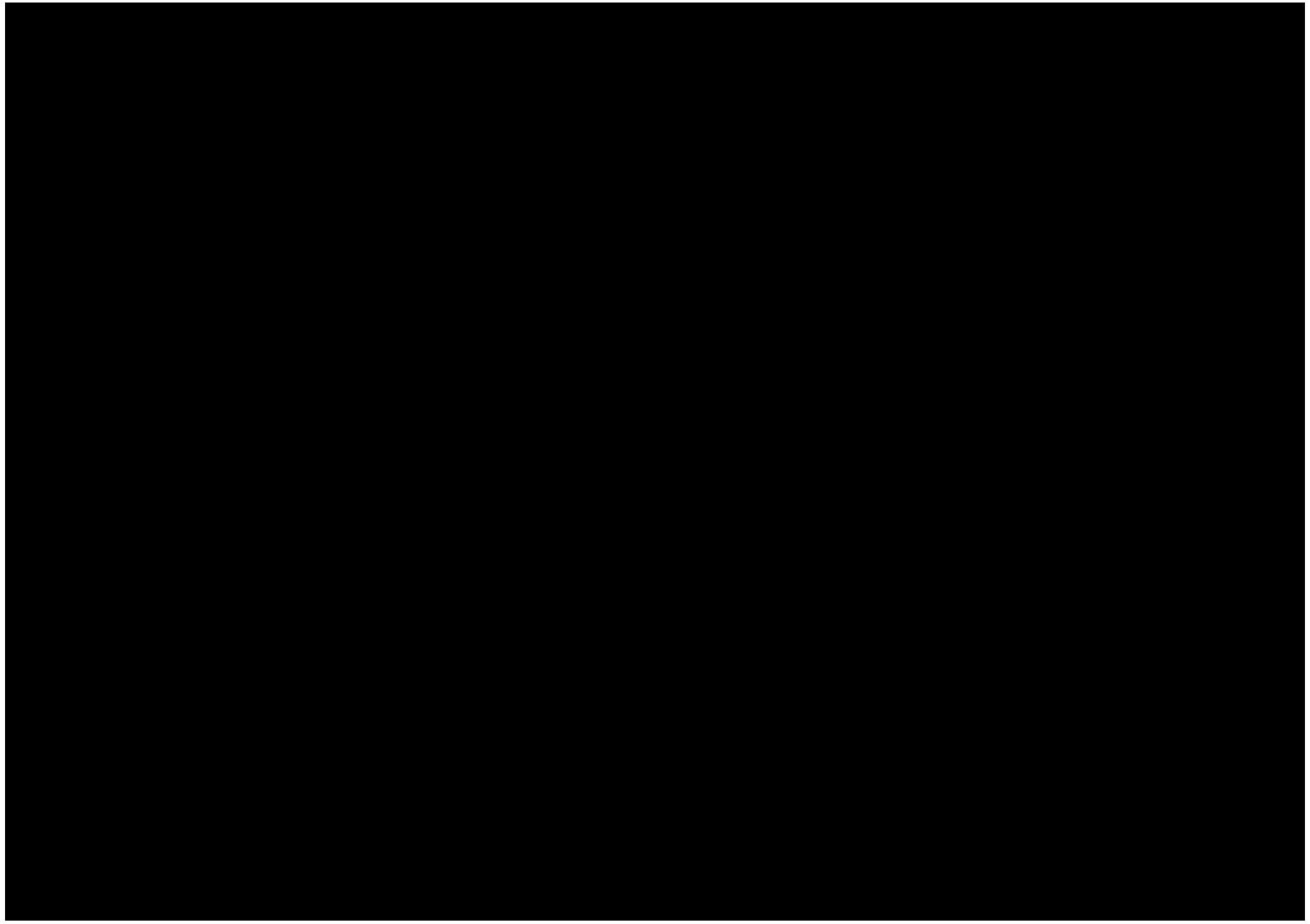



Text-based Screencast

Automated Assessment

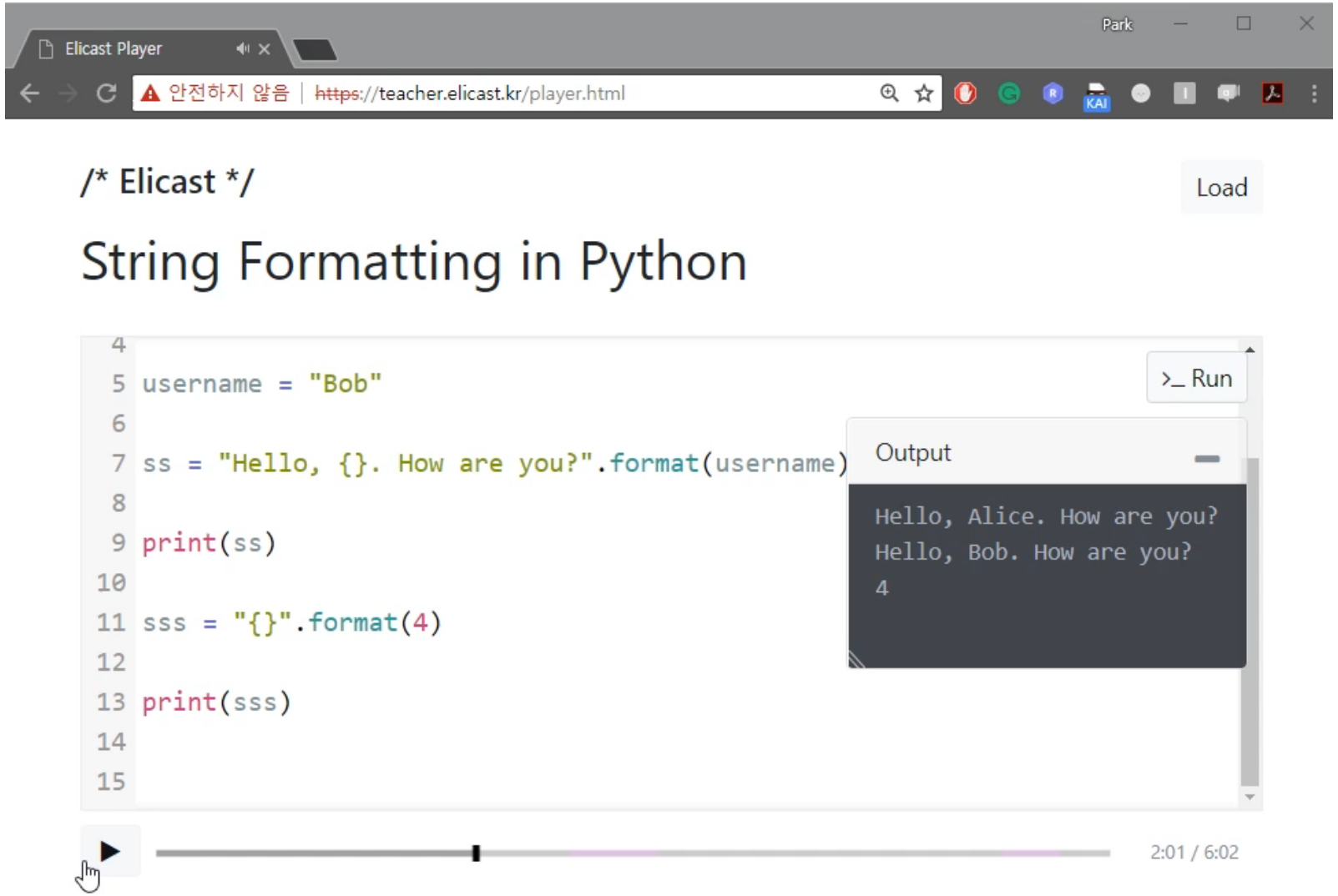
Embedded Exercise

# Text-based Programming Screencast



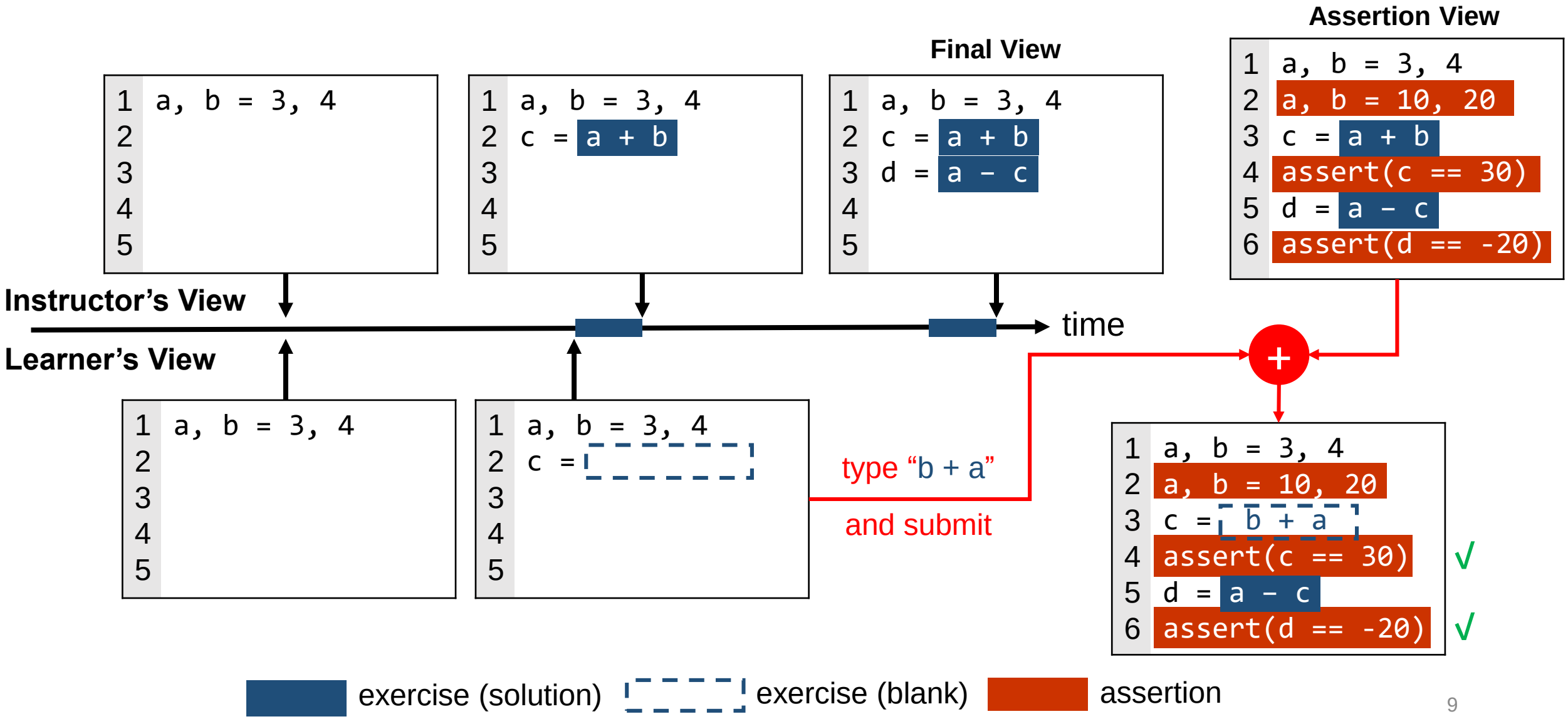
https://youtu.be/dKWlqDLgsm8

# Embedded Interactive Exercise




https://youtu.be/KZZIvBtDwXU

# Assertion-based Automated Assessment



# Exploratory Study

**Study 1**. Instructors record exercise embedded screencast

Q) how instructors make use of embedded exercise in creating screencast lectures?

**Study 2**. Learners watch screencast and engage in exercises

Q) how learners engage with the exercise embedded screencasts?

# Study 1. Instructors Record Exercise Embedded Screencasts

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At least 2 exercises / screencast
(~ 7 days) → Semi-structured Interview

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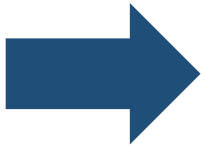

10 screencasts
(avg. 15.1 minutes)

36 embedded exercises

# Findings From Study 1

Modularized, checkpoint-style learning units

Assertions are easy-to-create yet limited

Expectation of pedagogical benefits

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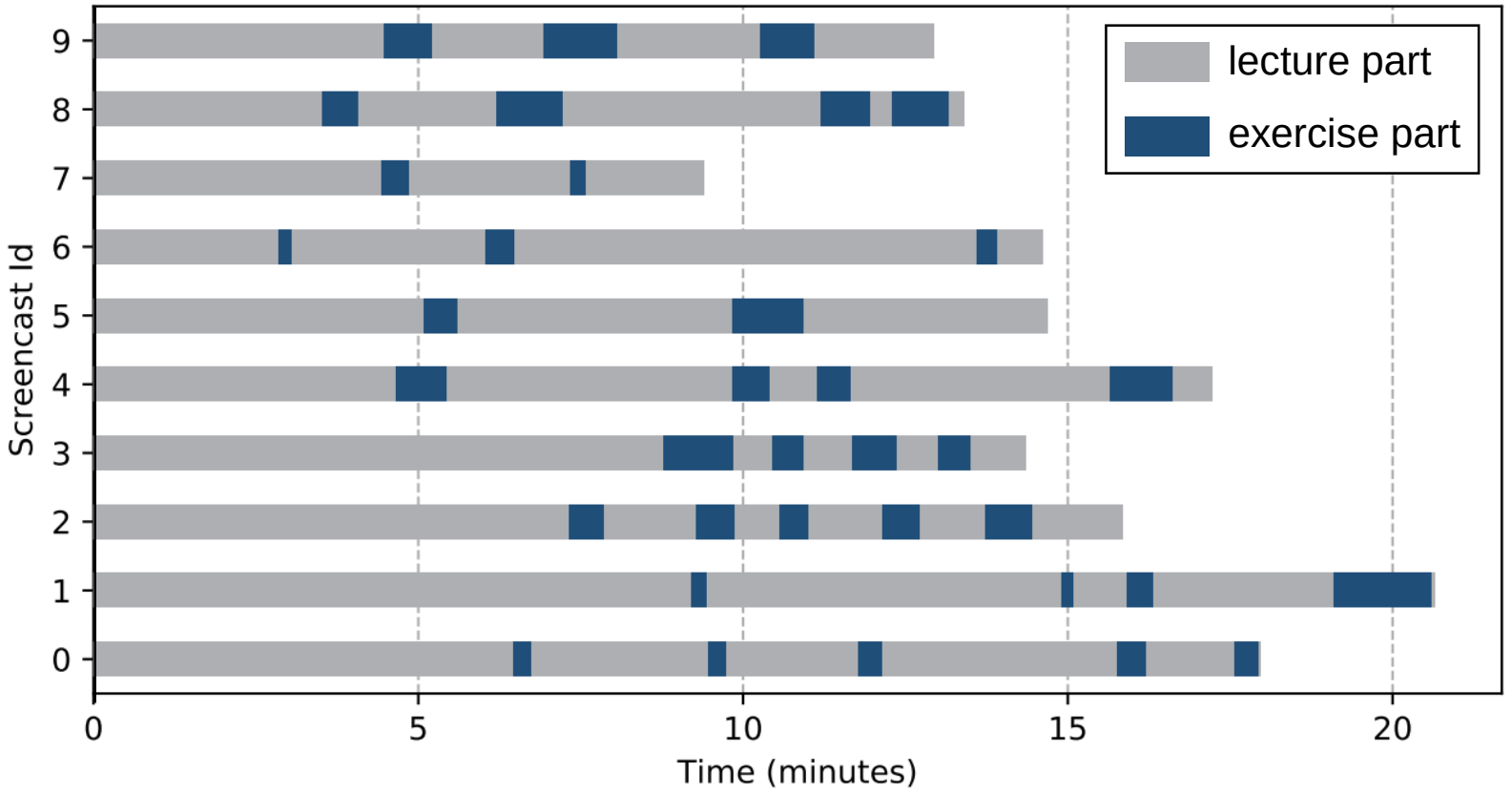
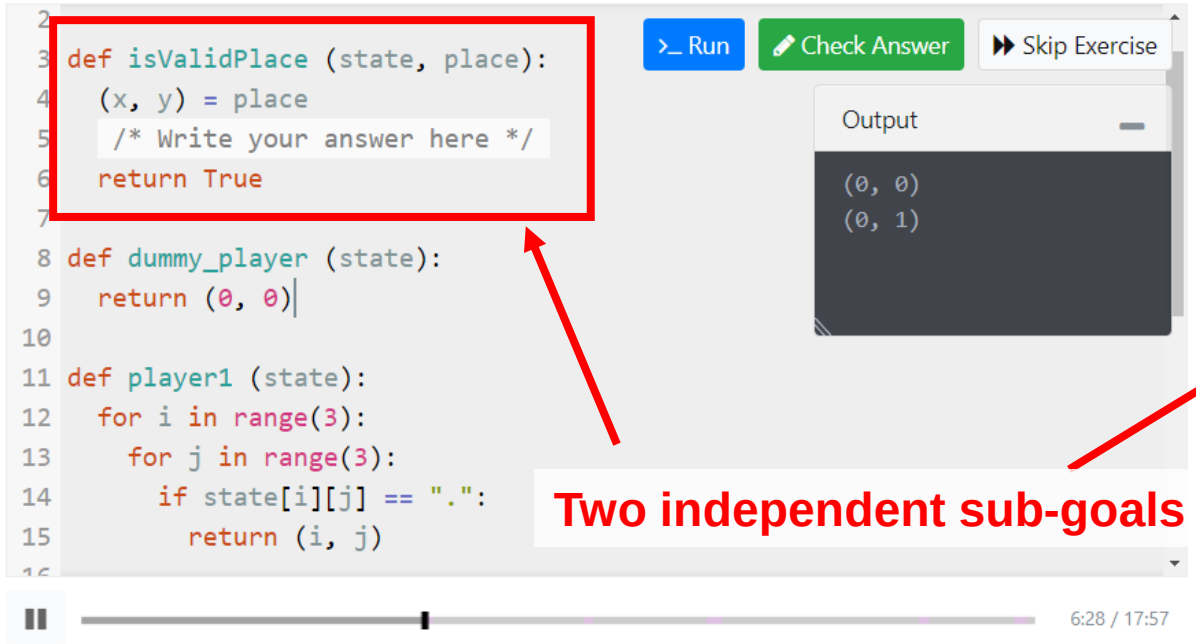
# Modularized, Checkpoint-style Learning Units

Instructors tended to organize each screencast lecture into smaller learning units.

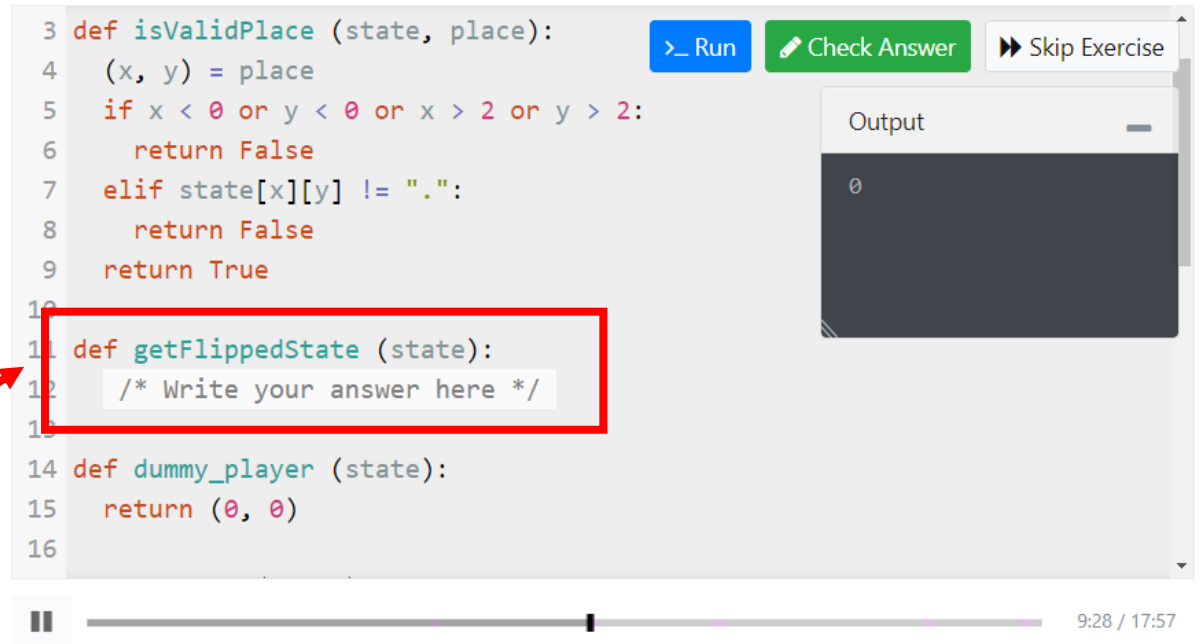


# Modularized, Checkpoint-style Learning Units

"With Elicast, what I felt different from the conventional lecture style was that I could define finer-grained goals of the lecture..." (instructor 1)

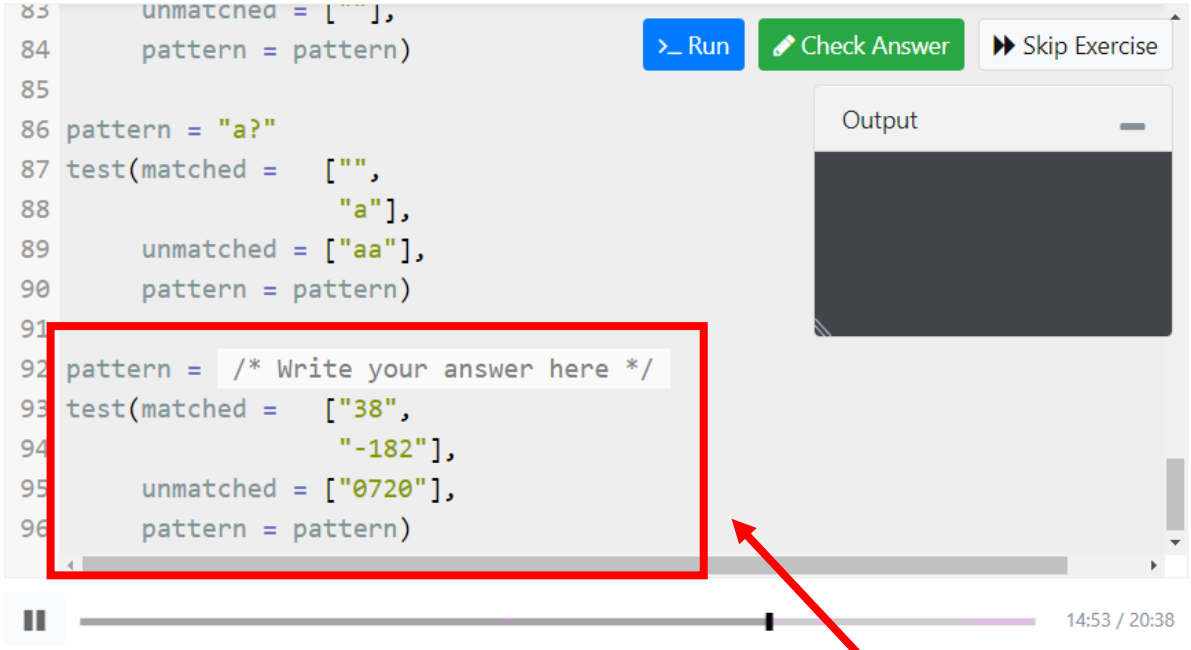


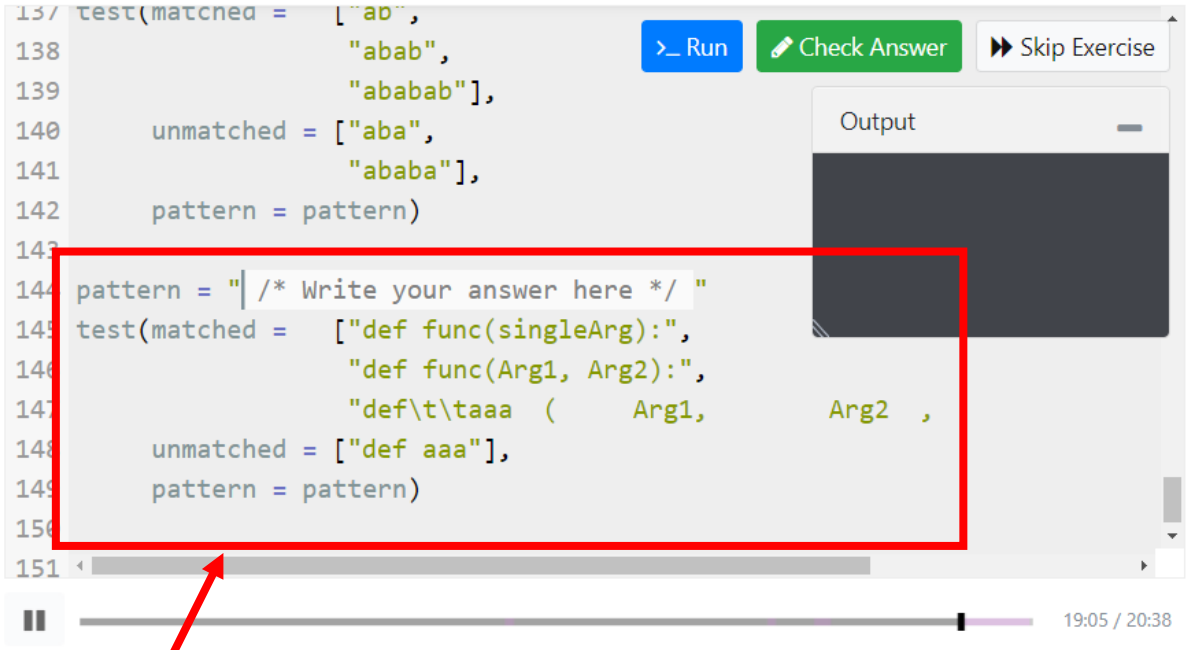

**Two independent sub-goals**



# Modularized, Checkpoint-style Learning Units

"... I felt I needed to schedule well to evenly distribute time and the level of difficulty among the exercises. This was the difference from my past online lecture..." (instructor 2)




**Examples with different difficulties**

# Findings From Study 1

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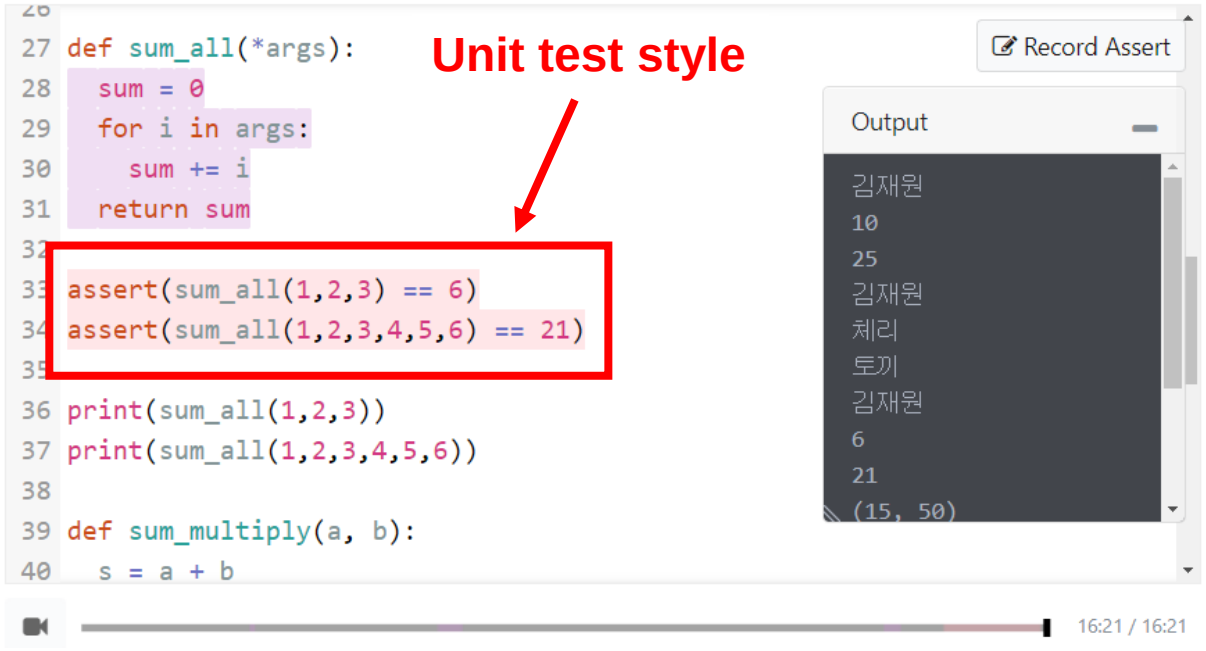
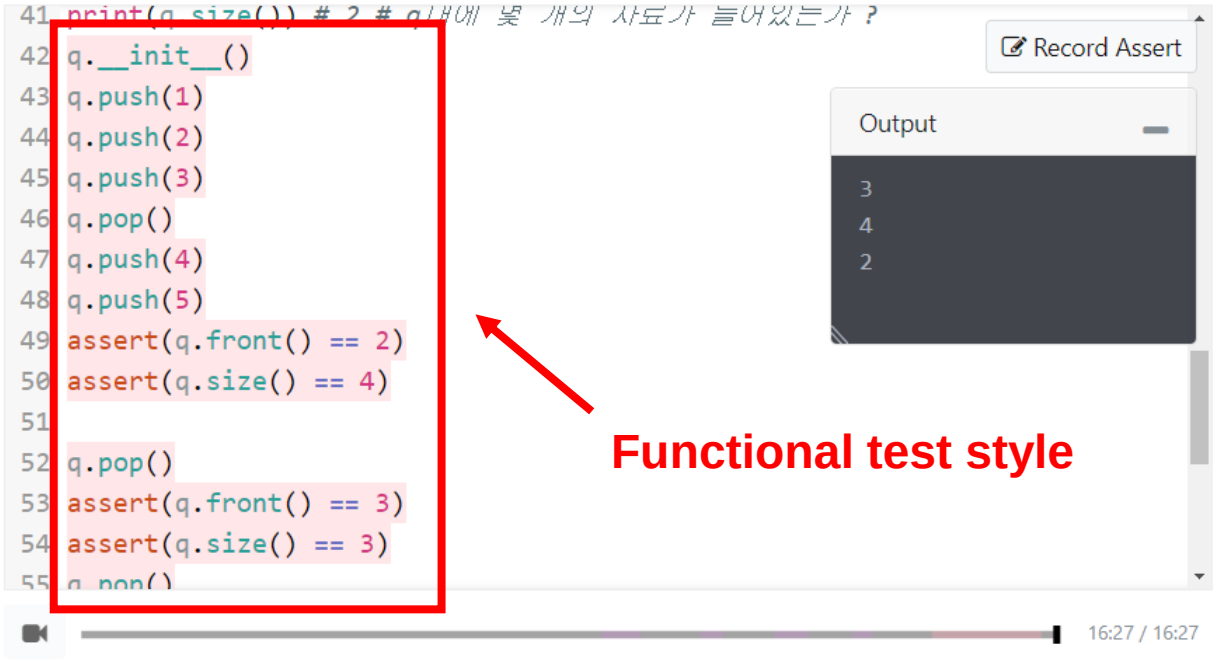
# Assertions Are Easy-to-Create Yet Limited

The instructors spent a median of 1.82 minutes on writing assertions.



# Assertions Are Easy-to-Create Yet Limited

“If I wanted to test a condition in an if statement, then it would be quite difficult. There are certain places I can set as an input field, …” (Instructor 1)

“Some things cannot be test with assertions. …, especially when assessing based on how well the student formed the code structure. This is essential when we teach novice students, …” (Instructor 4)

# Findings From Study 1

Modularized, checkpoint-style learning units

Assertions are easy-to-create yet limited

Expectation of pedagogical benefits

# Expectation of Pedagogical Benefits

While some instructors felt recording with Elicast took more time and effort, all expected that Elicast would be pedagogically beneficial to students.

> “I like the fact that students would feel they are writing code with me, rather than repeating after me … I like how students would feel they’re learning together.” (Instructor 1)

> “… this tool allows the instructor to quickly create small-sized exercises, which is intuitive to both instructor and students, and students can check if they actually understood the lecture – by doing.” (Instructor 4)

# Study 2. Learners Watch Screencast and Engage in Exercises

63 undergraduate students

The majority (46/63) had taken only one CS course before

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For each student,

| Id | Title | Duration | # exercises |
|---|---|---|---|
| L1 | Max Machine | 15:51 | 5 |
| L2 | Queue | 14:21 | 4 |
| L3 | Python RE | 20:38 | 4 |

**randomly select** → Screencast A, Screencast B → **randomly choose one and remove exercises** → Screencast A’, Screencast B or Screencast A, Screencast B’

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Repeat for Screencast A' and B / or / Screencast A and B'

# Findings From Study 2

Active engagement in lectures

Preliminary evidence on higher learning gains

Learning by doing

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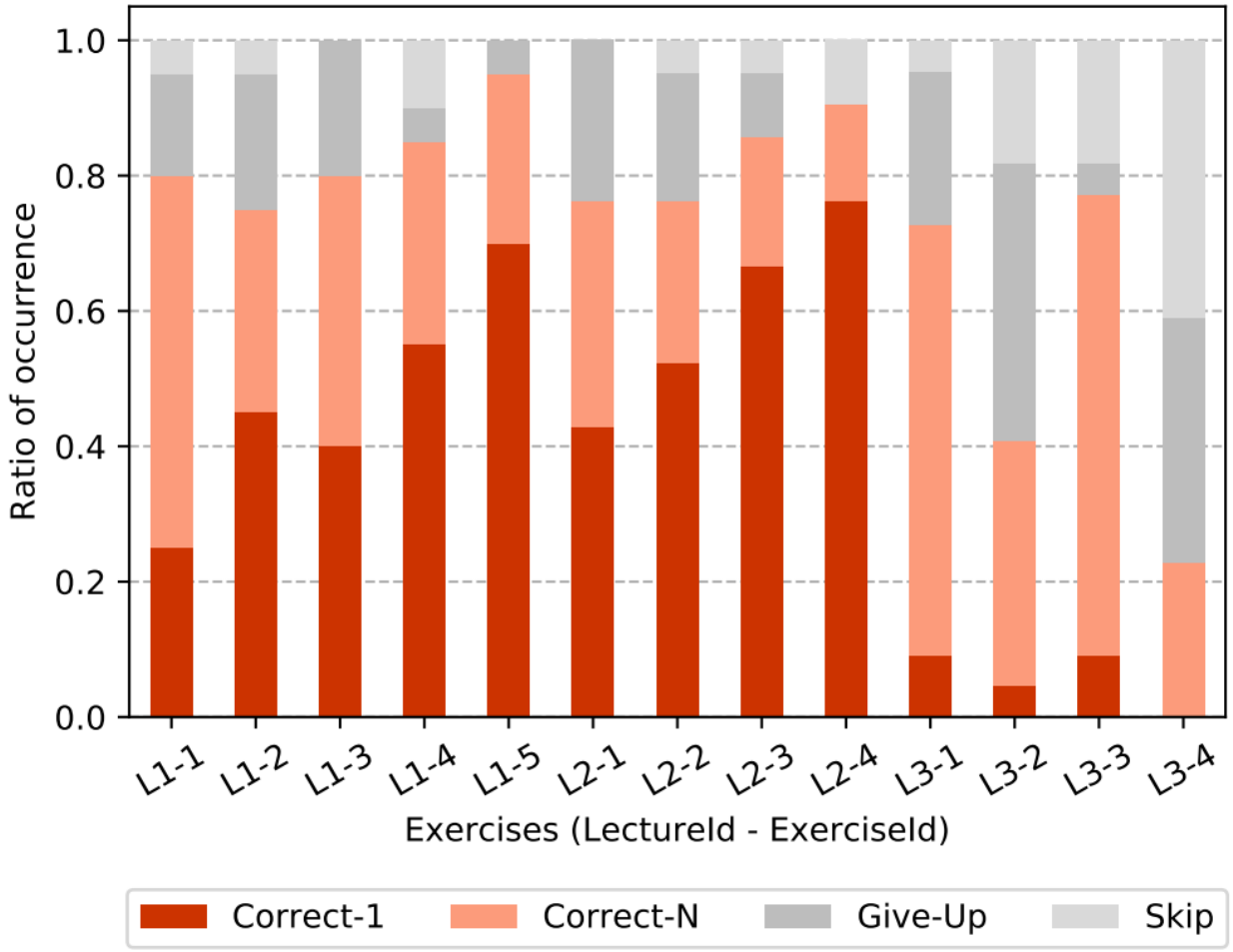
# Learners Engage in Lectures Actively




Tried at least once
(*Correct-1*,*Correct-N*,*Give-Up*)

90.44%

Correctly answered
(*Correct-1*,*Correct-N*)

73.16%

# Learners Engage in Lectures Actively

The number of video navigations per student

(play, pause, seeking)

| 25.16 | >> | 16.30 |
| --- | --- | --- |
| w/ Exercise | unequal var. t-test<br>*p < 0.005 | w/o Exercise |

# Learners Engage in Lectures Actively

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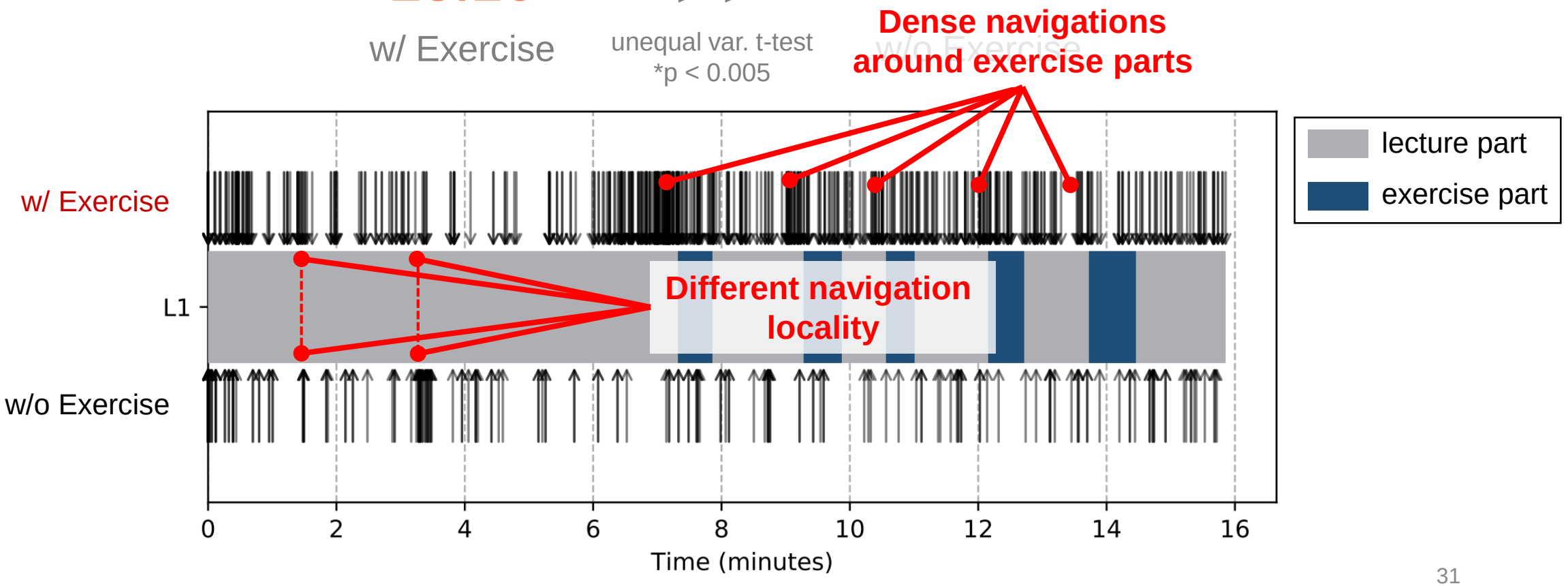
25.16 w/ Exercise

>>

unequal var. t-test
*p < 0.005

16.30 w/o Exercise



# Learners Engage in Lectures Actively

13 students mentioned that they were able to stay focused and be engaged throughout the lecture because of the embedded exercises.

> “Online lectures are usually disengaging, but I stayed focused this time in order to solve the problems.” (Student 17)

> “It made me take time to write code and apply things that I might have overlooked otherwise.” (Student 56)

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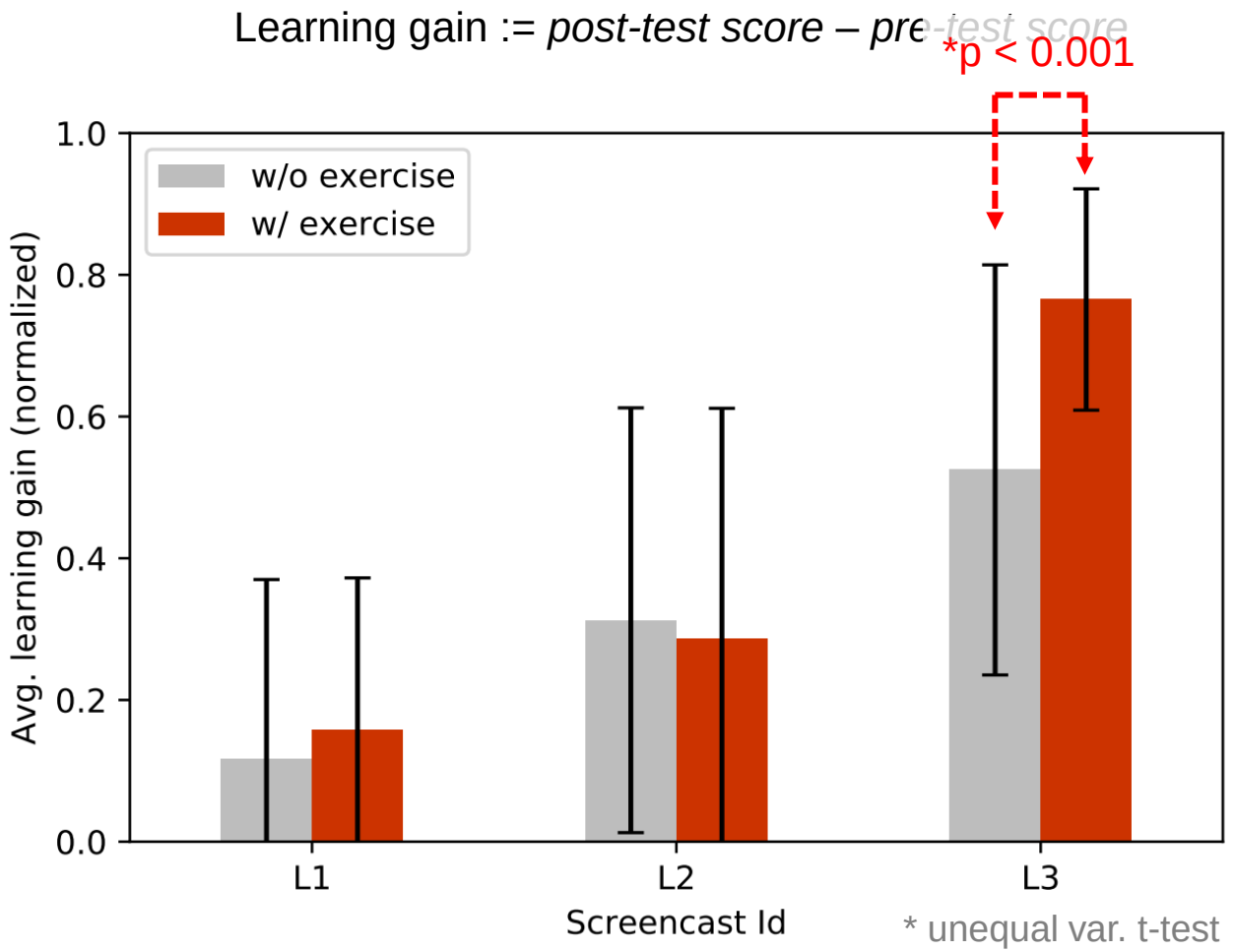
# Preliminary Evidence on Higher Learning Gains



# Preliminary Evidence on Higher Learning Gains

| | |
|---|---|
| *Applying What I just Learned (11)* | "I realized that understanding something conceptually is quite different from applying it in practice" (Student 43) |
| *Checking for Understanding (8)* | "… It gave me a chance to think twice about the contents that I was going to go through in confusion." (Student 58) |
| *Memorizing (6)* | "Solving the exercises during the lecture, I was able to take control of my own learning, and I will probably remember longer through repetition of the concept" (Student 11) |

# Findings From Study 2

Active engagement in lectures

Preliminary evidence on higher learning gains

Learning by doing

# Elicast Promotes Learning by Doing

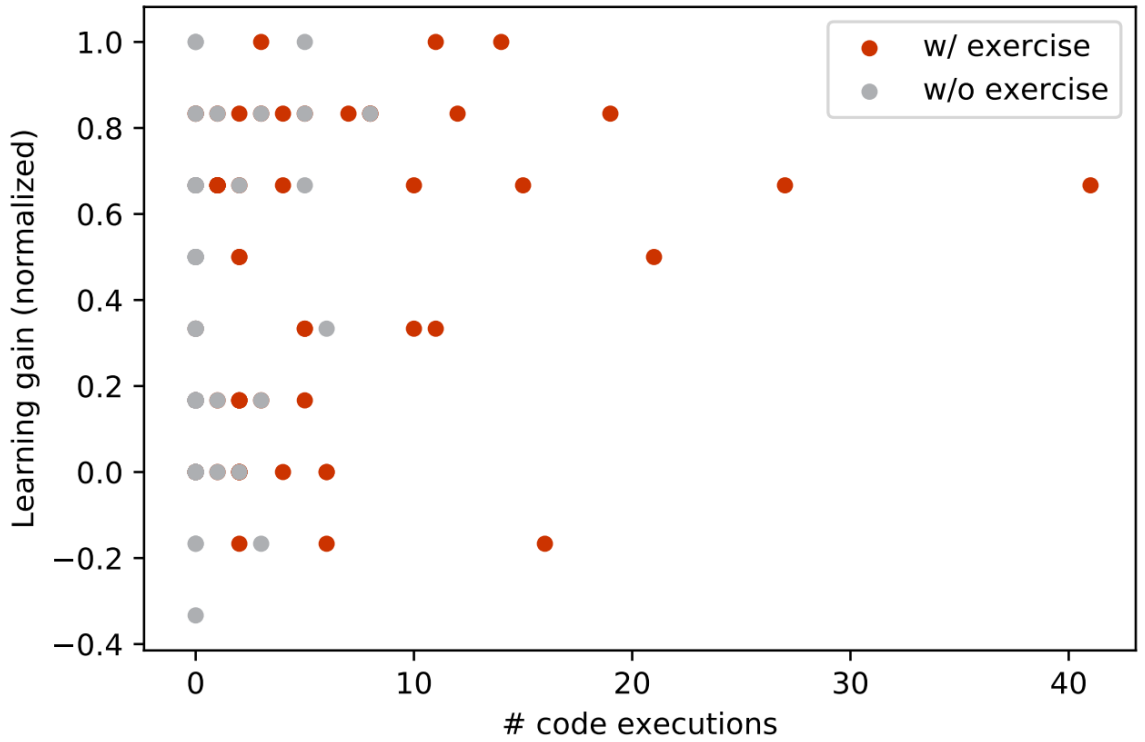
The number of code executions
(excluding submissions for exercises)

| 5.14 | >> | 0.71 |
| --- | --- | --- |
| w/ Exercise | unequal var. t-test<br>*p < 0.001 | w/o Exercise |

# Elicast Promotes Learning by Doing

(Pearson's $r = .26$)

Positive correlation between the number of code executions and learning gain



# Future Direction

## Provide learners' activity as feedback to instructors

> "The most skipped exercise would be my primary interest. Then I would improve my lecture based on that data." (Instructor 2)

> "… Lecturers could know who did not understand which part of the lecture. … This could not be done in my past lecture experiences." (Instructor 4)

## Provide more guidance for exercises to learners

> "... but I thought I needed some hints that would guide me in solving problems and lead me to the intended direction ..." (Student 31)

# Summary

- We present **Elicast**, a screencast tool for recording and viewing programming lectures with **embedded programming exercises**
- Elicast positively influenced the behaviors of both instructors and learners
  - Instructors – smaller learning units using embedded exercises as checkpoints
  - Learners – active engagement in the lecture with embedded programming exercises

Code: https://github.com/**elicast-research/elicast**

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