Using Comics to Introduce and Reinforce Programming Concepts in CS1

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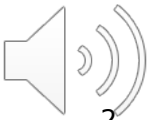


Motivation

CS1 : Goals & Challenges

- Goals
  - Increasing students' **interest & confidence**

- Challenges
  - Learn abstract, arbitrary conventions and syntax
  - Trace the sequence of execution steps

  => make programming **difficult** and **less interesting**

CS1 : Goals & Challenges

- Goals
  - Increasing students' **interest & confidence**

- Challenges
  - Learn abstract, arbitrary conventions and syntax
  - Trace the sequence of execution steps

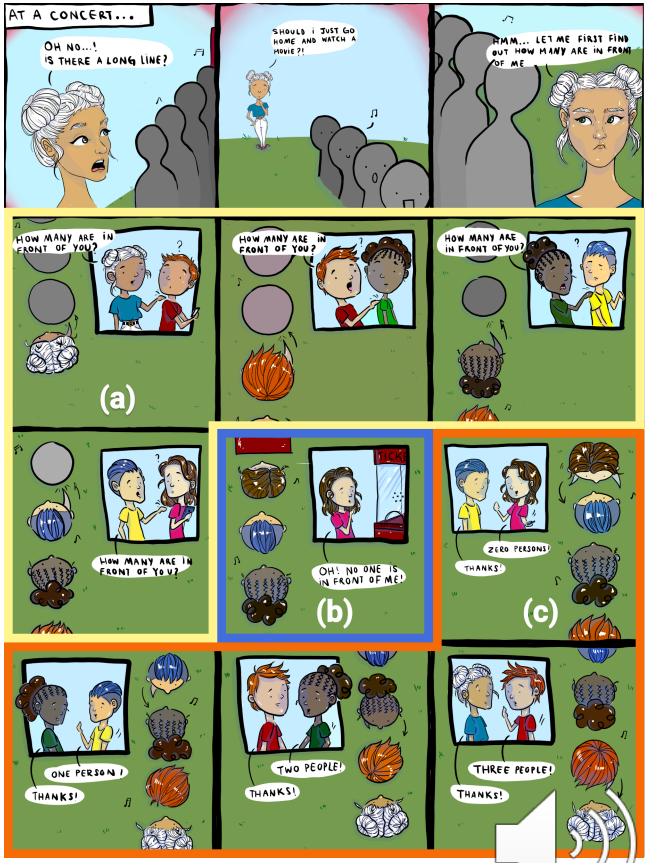
=> make programming **difficult** and **less interesting**

Coding Strip (VL/HCC'20)

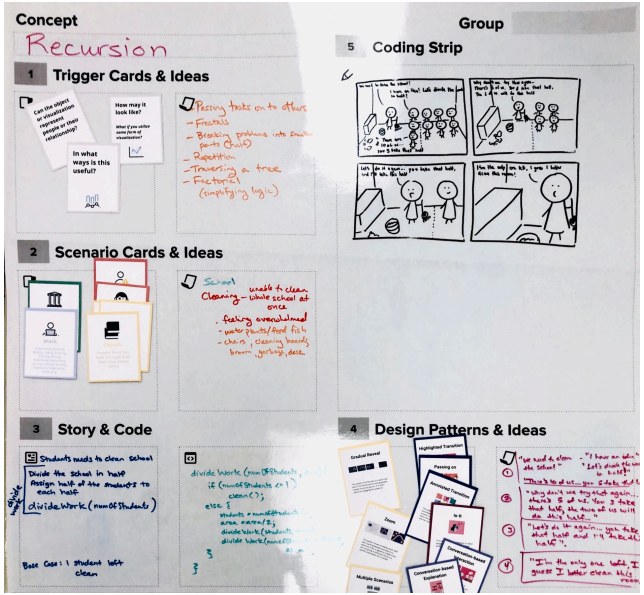
- A form of **comic strip** with **corresponding code** for introducing and teaching programming concepts

```
def how_many_in_line (num_of_people):
    if num_of_people == 0:                    (b)
        return 0
    else:
        return 1 + how_many_in_line (num_of_people - 1)    (c)
                                              (a)

how_many_in_line (4)   (a)
```

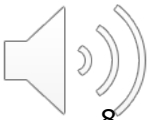


Coding Strip (VL/HCC'20)



Coding Strip Use Cases (SIGCSE'21)

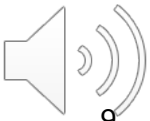
- **Experience Report**
  - Administered four coding strip use cases in CS1
  - Surveyed students



Coding Strip Use Cases (SIGCSE'21)

- **Experience Report**
  - Administered four use cases of coding strip in CS1 course
  - Surveyed students

- **Contributes**
  - Description of four use cases of coding strips
  - Analysis of perceived usefulness of comics and use cases
  - Summary of benefits and challenges with using *coding strip*

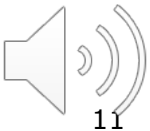


Methods

Course & Students, Use Cases, Survey

Course & Students

- **Course (N=49)**
  - 1st-year CS course for non-CS students
    - Required for students in Digital Arts Program
  - Creative coding approach
    - P5.js, a Javascript library for creative coding

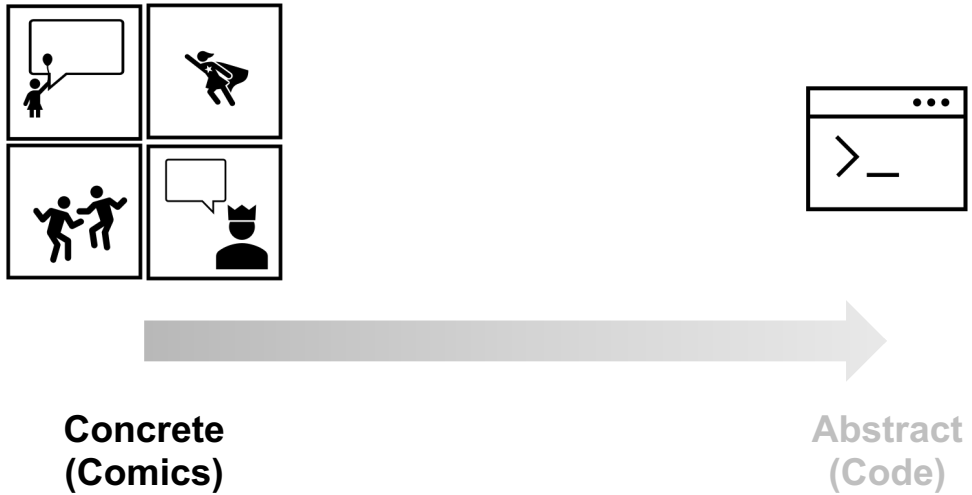


Use Cases (UCs)

- **UC1**. Introduce Concept

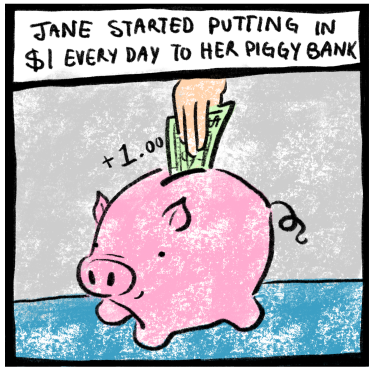
Use Cases (UCs)

- **UC2**. Introduce Code



Use Cases (UCs)

- **UC2**. Introduce Code



→

Assigning Value to User-defined Variables

name assign

```
piggyBank = 1;
```

variable **assignment** statement

→

Declare, Assign Later vs Declare & Assign ("Initialize")

```
// Day 0
let piggyBank;
.
.
.
// Day n (n = 1, 2, ...)
piggyBank = 1;
```

```
// Day 0
let piggyBank = 1;
```

Use Cases (UCs)

- **UC2.** Introduce Code

Loop repeats while condition is true

While Dormammu refuses,
Dr. Strange says, "I have come to bargain!"
Dr. Strange dies.

For example, we can express "endless looped time" as

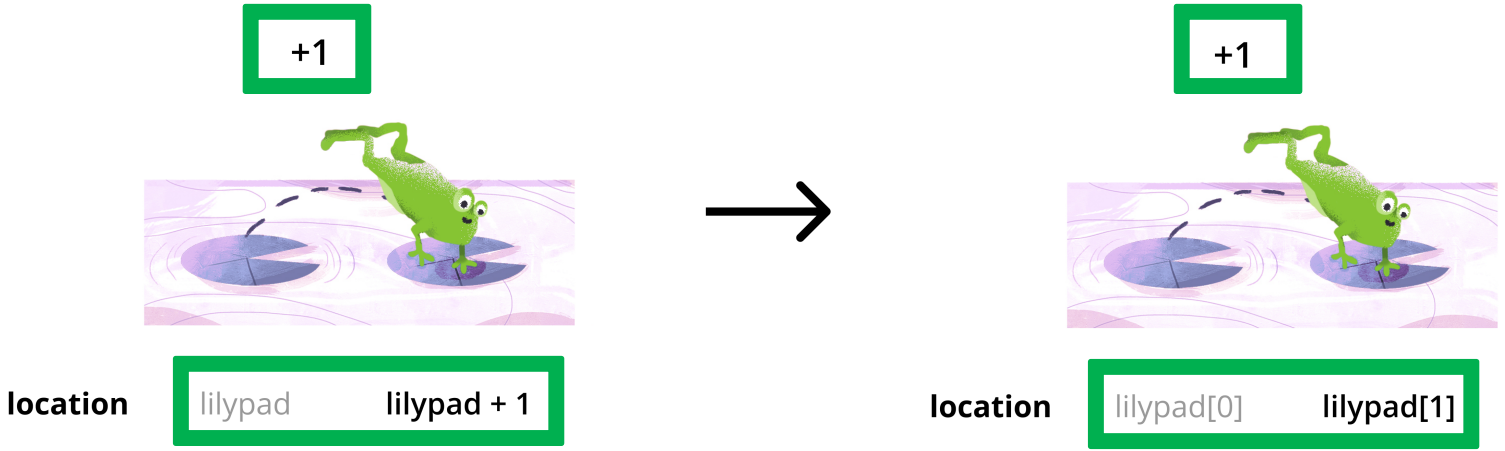
condition

```
while ( dormammu_refuses ) {
  print("I have come to bargain!");
  dies();
}
```

repeat

Use Cases (UCs)

- **UC2**. Introduce Code



Use Cases (UCs)

- **UC3**. Review Concepts and Code

What does this code print at 2nd frame?

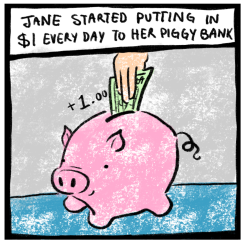
```
let name = “PETER PARKER”;
let mood = “Baby”;
let age = 1;

function setup() {
    age = 16;
    print(age);
}

function draw() {
    age = 20;
    print(age);
}
```

A	1
B	2
C	16
D	20

What does this represent?



A. Declaring variable

B. Assigning value to variable

C. Creating constant

D. None of the above

What is the index of the last element?

lilypad[?]

A. 0

B. 3

C. 4

D. 5

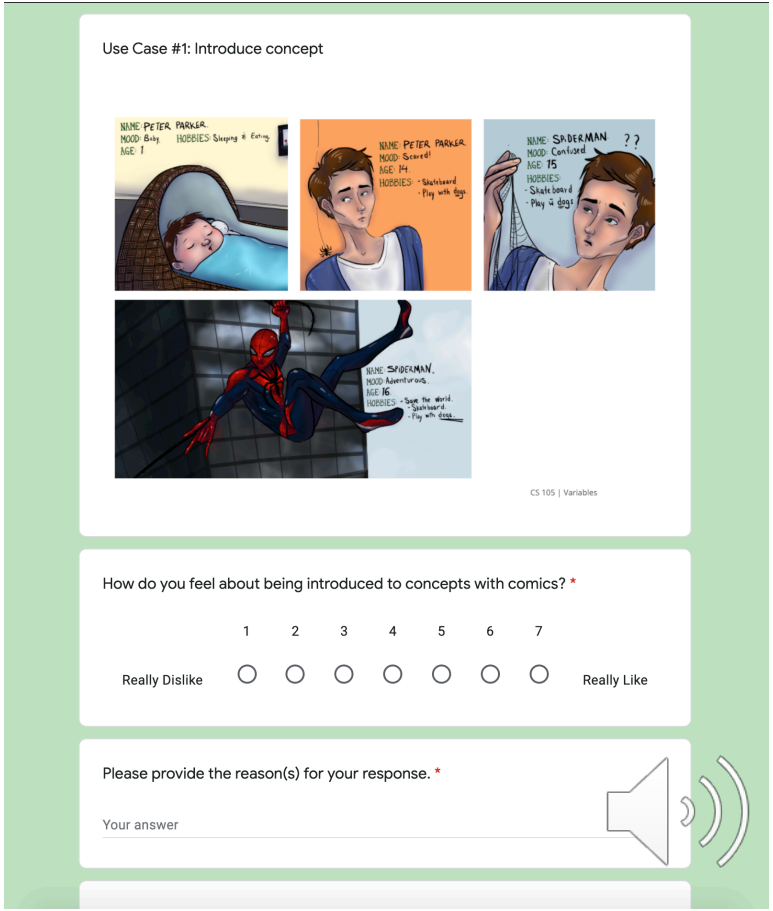
E. 6

Use Cases (UCs)

- **UC4**. Write Code from Comics

Survey

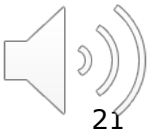
- **Google Form**
- **Question types**
  - Demographic
  - Comics
    - General (comics)
    - Specific (each use case)
  - Recommend



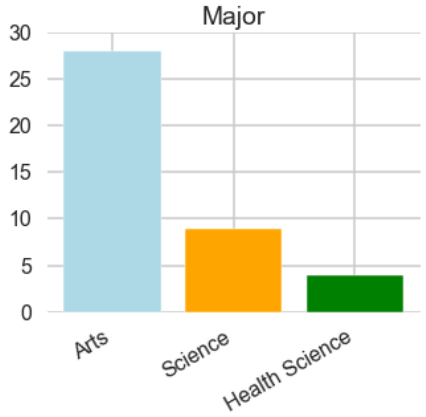
Results

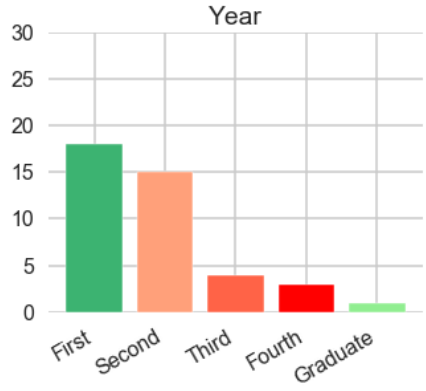
Results

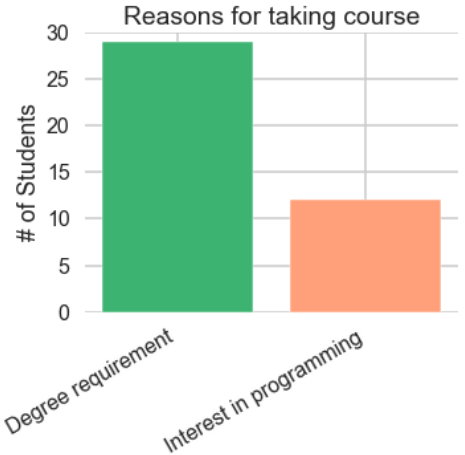
- Demographic
- Analysis
  - Each Use Case
  - Overall Experience
    - Comics in General
    - Recommend



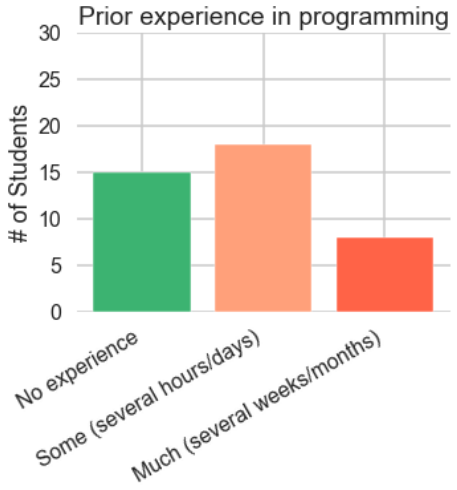
Demographics (N=41/49)

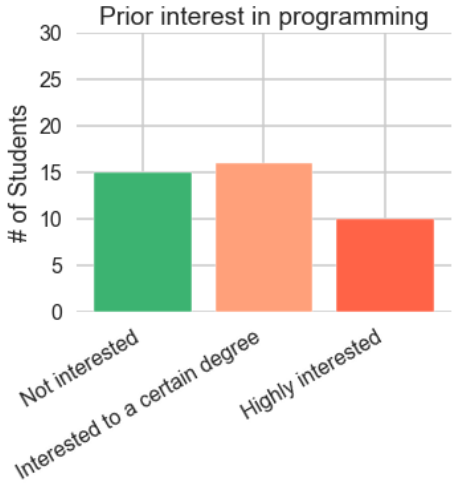


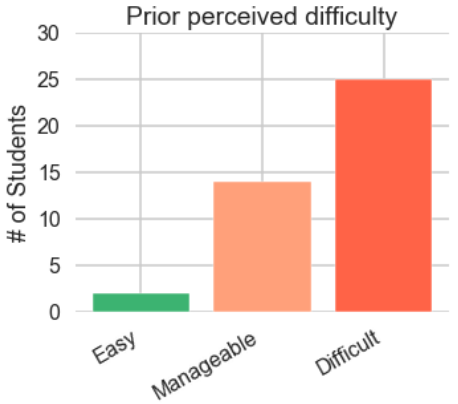




Demographics (N=41/49)

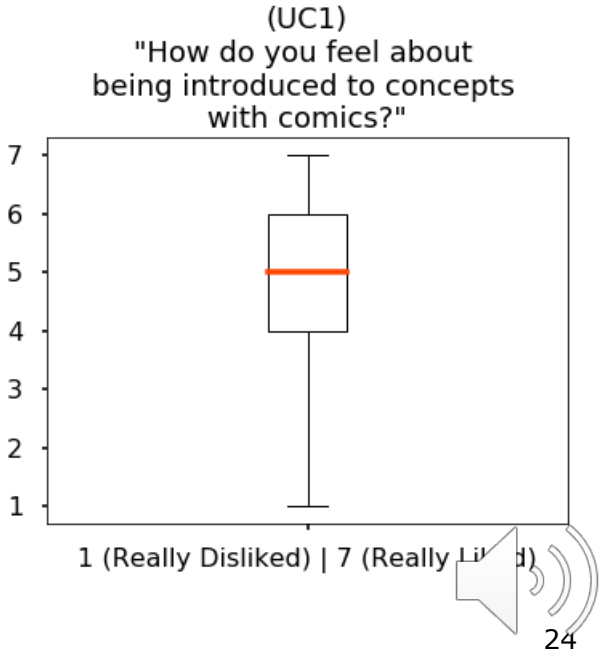






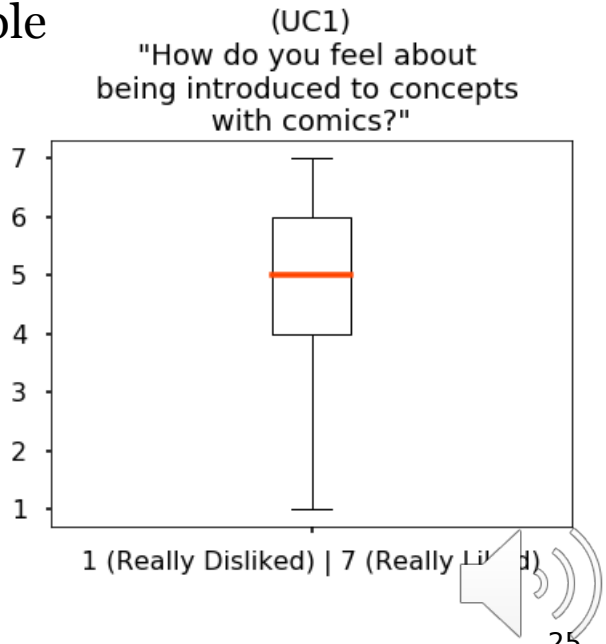
UC1. Introduce Concept (M=4.9/7)

- Students liked being introduced to concepts with comics
  - 85% (35/41) of the students rated it positively (scores of 4-7)



UC1. Introduce Concept (M=4.9/7)

- Reasons (Scores of 4-7)
  - Made concepts more fun, engaging, and relatable
  - Helped understand and make sense
    - Explain "*why*"
    - "*Visualize the concept*"
    - "*Simplify tricky concepts*"
    - Provide "*analogy*" and "*metaphor*"



UC1. Introduce Concept (M=4.9/7)

- Reasons (Scores of 4-7)
  - The **sequential nature of comics** was also helpful in understanding the procedural aspect of the concepts

"*A lot of the time, we* ***don't know what the program is doing****; the comics made a* ***logical sequence of concepts*** *that made it* ***easier to learn***."

UC1. Introduce Concept (M=4.9/7)

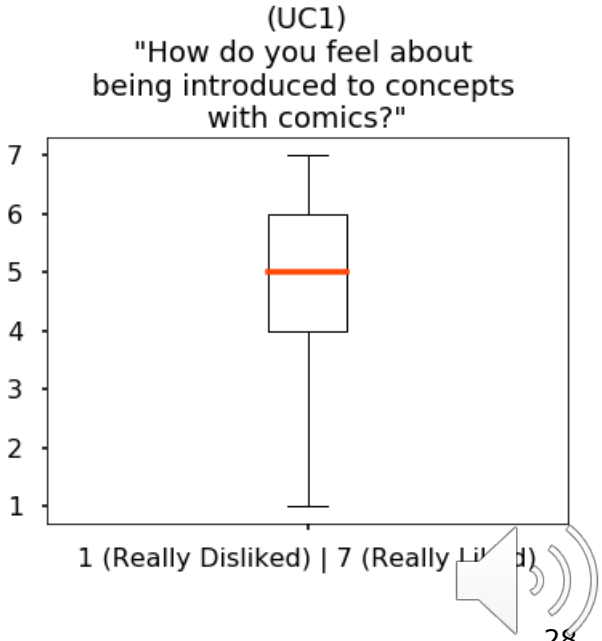
- Reasons (Scores of 4-7)
  - Helped remember and easily recall

"For example, everytime I want to remember what loop does, I just ***recall the comic back in my mind****."*

"I ***remembered*** *the [comics]* ***during the midterm****, so I found it helpful"*

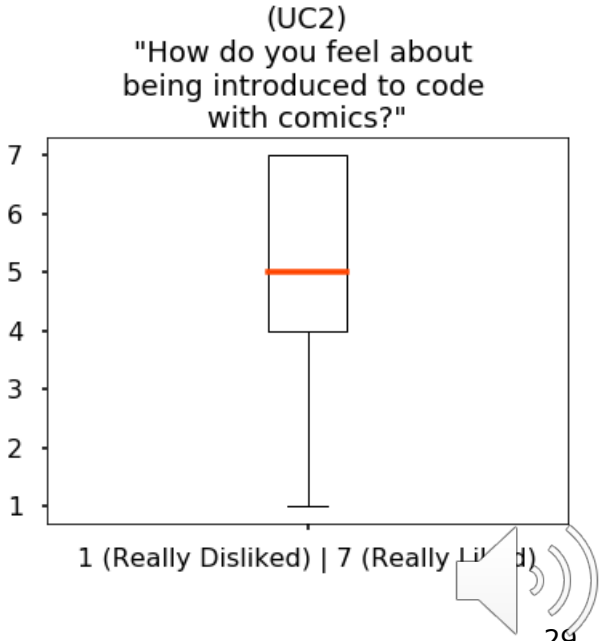
UC1. Introduce Concept (M=4.9/7)

- Reasons (Scores of 1-3)
  - Confusing
    - How comics and concepts correlate
    - Prefer analogy alone



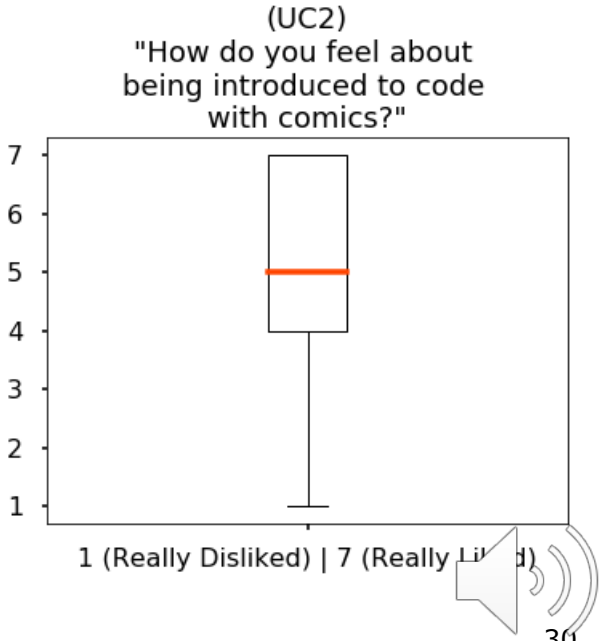
UC2. Introduce Code (M=5/7)

- Students liked being introduced to code with comics
  - 78% (32/41) of the students rated it positively (scores of 4-7)



UC2. Introduce Code (M=5/7)

- Reasons (Scores of 4-7)
  - Made learning code more engaging, fun
  - Made code easier to understand
    - Provide visual structure
    - Show logic behind code
  - Compared to code-only approach
    - Made code easier to remember
    - Focus on understanding vs. memorizing



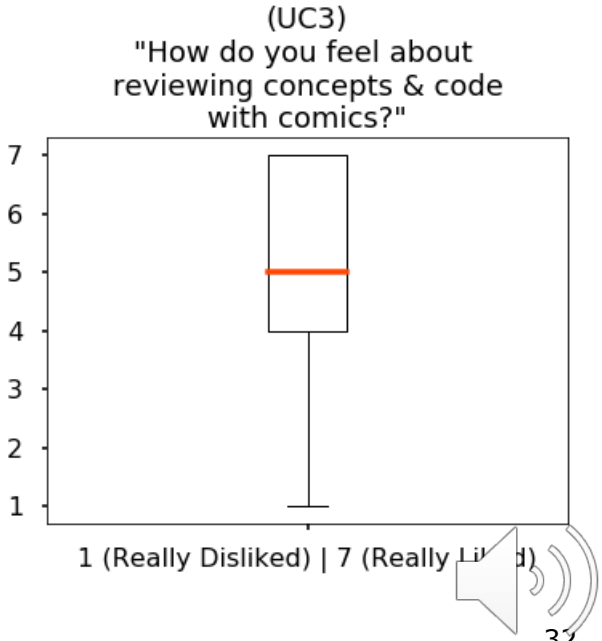
UC2. Introduce Code (M=5/7)

- Reasons (Scores of 4-7)
  - Relieved anxiety
  - Developed a positive attitude

- Reasons (Scores of 1-3)
  - Confusing
  - Unnecessary

UC3. Review Concepts and Code (M=4.9/7)

- Students enjoyed reviewing with comics
  - 76% (31/41) of the students rated it positively (scores of 4-7)



UC3. Review Concepts and Code (M=4.9/7)

- Students generally performed better when clicker questions referenced comics (60% < 74, 67, 86%)

What does this code print at 2nd frame?

```
let name = "PETER PARKER";
let mood = "Baby";
let age = 1;

function setup() {
    age = 16;
    print(age);
}

function draw() {
    age = 20;
    print(age);
}
```

A 1

B 2

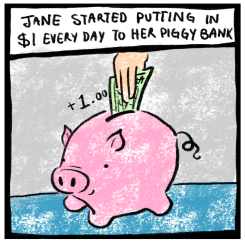
C 16

D 20

74%

(**34**% on isomorphic question)

What does this represent?



A. Declaring variable

B. Assigning value to variable

C. Creating constant

D. None of the above

67%

What is the index of the last element?

lilypad[?]

A. 0

B. 3

C. 4

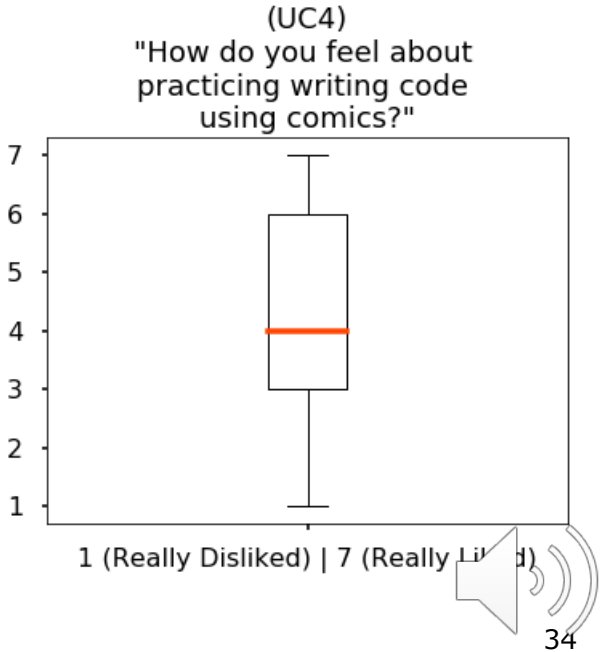
D. 5

E. 6

86%

UC4. Write Code from Comics (M=4.2/7)

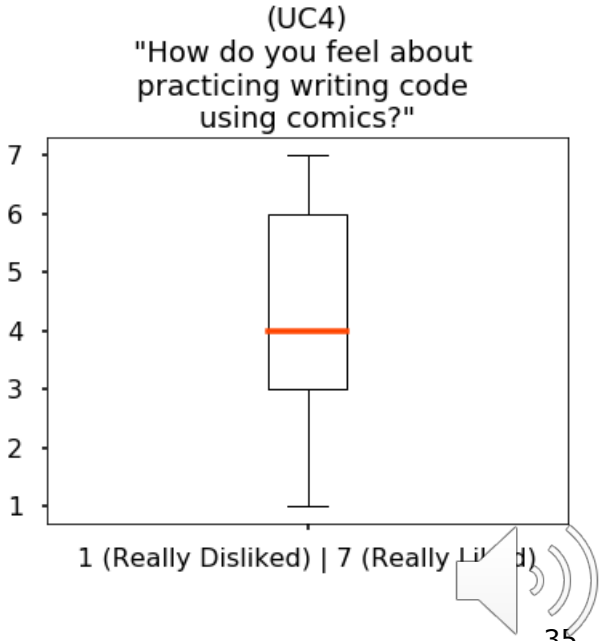
- Compared to other use cases, students were not as positive
  - 63% (26/41) of the students rated it positively (scores of 4-7)
    - Difficult
    - Unclear



UC4. Write Code from Comics (M=4.2/7)

- Reasons (Scores of 4-7)
  - Want to learn more
  - Fun & useful practice

    (e.g., “very useful to practice and go over the concepts in a limited time”)



UC4. Write Code from Comics (M=4.2/7)

- Reasons (Scores of 4-7)
  - Made programming less intimidating & more interesting

> "*I have **always tried to find the 'right' answer** because I have been educated that there is only one right … However, this **made me more interested in programming** after realizing that in programming, **there is no right answer** and the result depends on what I'm creating and expressing.*"

UC4. Write Code from Comics (M=4.2/7)

- Students' code submissions showed students' **unique interpretations & creative ideas**


```
for (let day = 1; day <= 100; day++) {
    eat (captain_crunch);
}
```

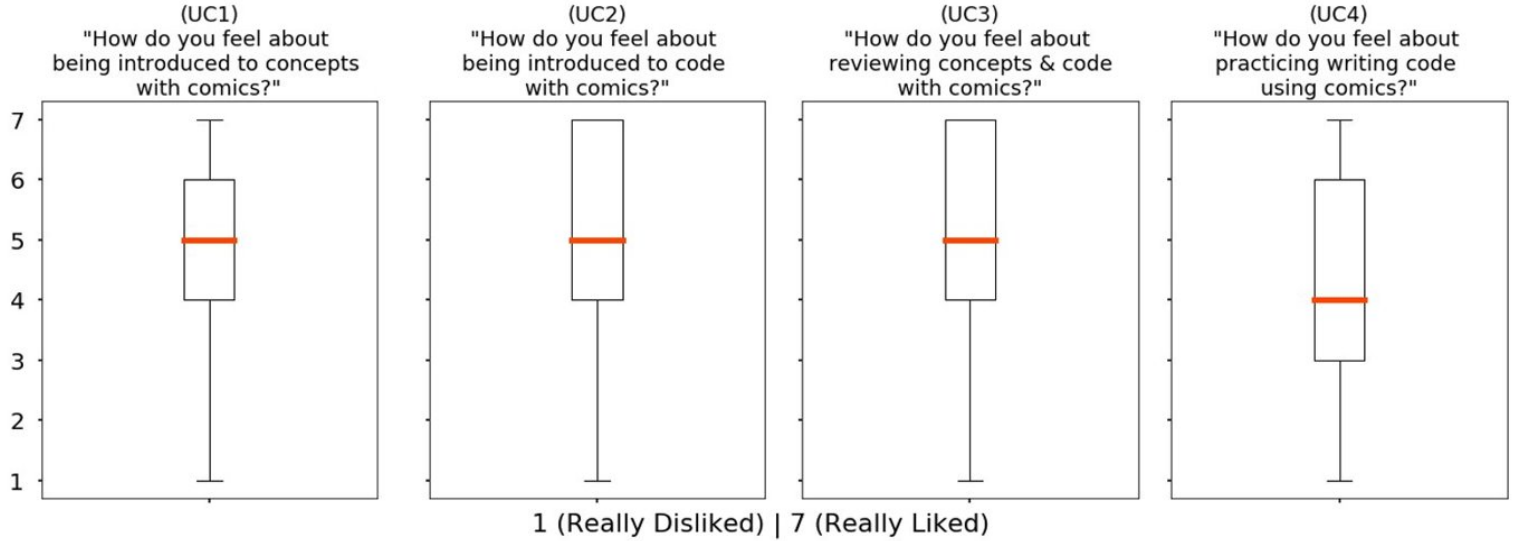
Instructor's code

```
let interest;
for (let i = 0; i < 100; i ++) {
    interest -= 1;
}
```

Student's submission

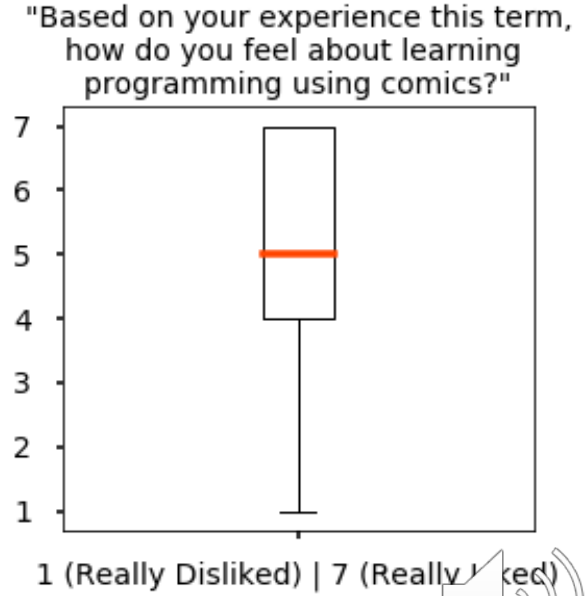
Analysis of Each Use Case

- All use cases, except for UC4, were rated positively.



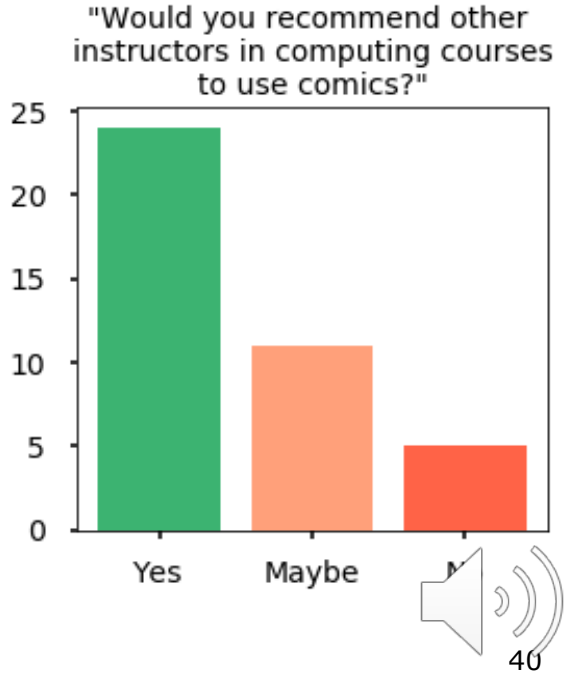
Analysis of Overall Experience (M=5.2/7)

- Students were highly positive about the overall idea of learning programming using comics
  - 85% (35/41) of the students rated it positively (scores of 4-7)



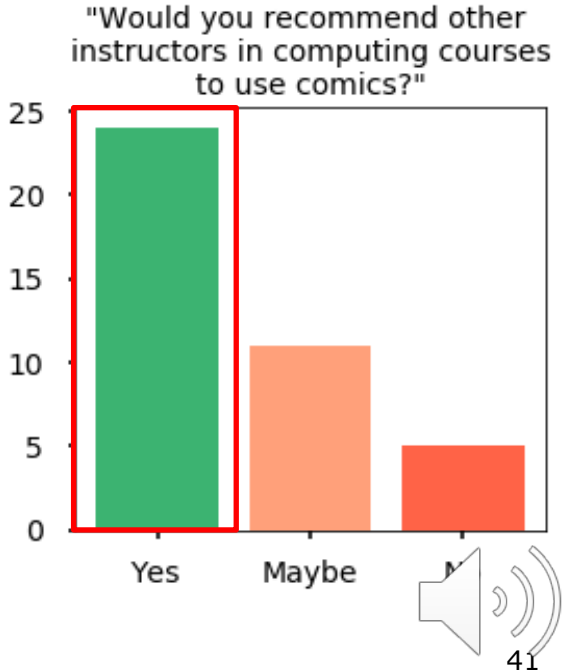
Analysis of Overall Experience (M=5.2/7)

- 61% (25/41) recommended the use of comics, some (11) were hesitant and few (5) against it



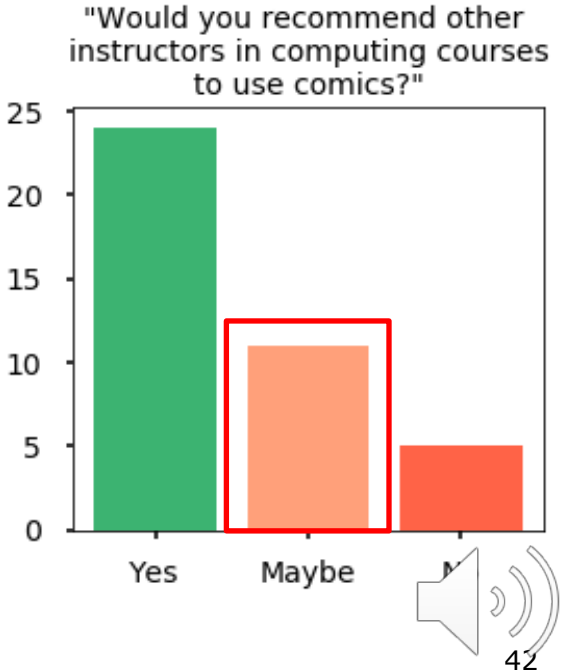
Analysis of Overall Experience (M=5.2/7)

- Reasons for Recommending ("Yes")
  - Fun, engaging, motivating
  - Help understand & remember
  - Appealing way for “visual learners”
  - Positive impact on classroom atmosphere



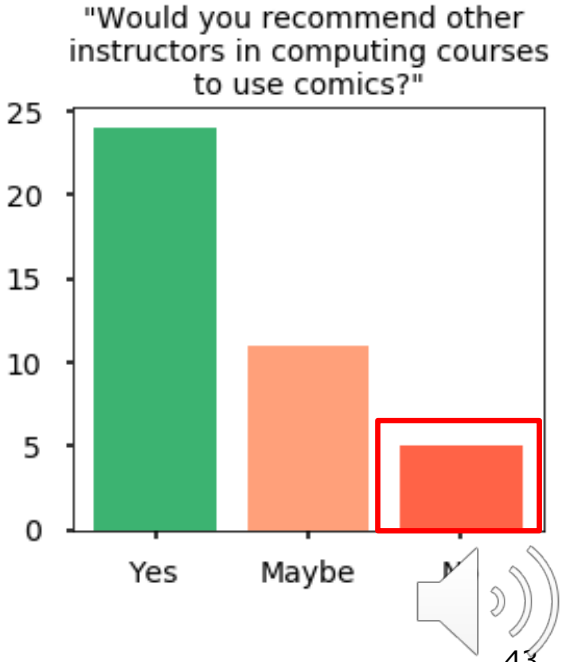
Analysis of Overall Experience (M=5.2/7)

- Reasons for Reservation ("Maybe")
  - Usefulness depends on…
    - Comics
    - Students
      - learning style
      - affinity for comics
    - Use case



Analysis of Overall Experience (M=5.2/7)

- Reasons for Not Recommending ("No")
  - Confusing
  - Not their “learning style”



Summary & Future Work

- Students enjoyed & experienced various benefits
- While our work does not contribute any measurement of learning impact, it provides valuable findings to help facilitate the use of coding strips
- The “learning style” misconception appears to be another challenge that needs to be addressed

Summary & Future Work

- Improve coding exercise (**UC4**) with clear guidelines and examples
- Investigate
  - what makes certain comics more confusing
  - whether coding strips are more useful for certain concepts
  - how to accommodate blind or visually impaired students

Acknowledgements

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