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

```python
def how_many_in_line(num_of_people):
    if num_of_people == 0:
        return 0
    else:
        return 1 + how_many_in_line(num_of_people - 1)

how_many_in_line(4)  # (a)
```

Suh et al, Coding Strip: A Pedagogical Tool for Teaching and Learning Programming Concepts through Comics
Coding Strip (VL/HCC'20)

Suh et al, Coding Strip: A Pedagogical Tool for Teaching and Learning Programming Concepts through Comics
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

Concrete (Comics)

Abstract (Code)
Use Cases (UCs)

- **UC2. Introduce Code**

Assigning Value to User-defined Variables

```
name          assign
\downarrow          \downarrow
piggyBank = 1;
```

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**

  1: Dormammu, I have come to bargain!

  2: Dormammu, I have come to bargain!

  3: Dormammu, I have come to bargain!

  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

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

  repeat

  condition
Use Cases (UCs)

- **UC2.** Introduce Code

  ![Diagram showing location changes from lily pad to lily pad + 1]

  ![Diagram showing location changes from lily pad[0] to lily pad[1]]
Use Cases (UCs)

- **UC3. Review Concepts and Code**

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

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

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

What does this code print at 2nd frame?

- 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?

- 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

Use Case #1: Introduce concept

How do you feel about being introduced to concepts with comics? *

1 2 3 4 5 6 7
Really Dislike

Please provide the reason(s) for your response. *

Your answer
Results
Results

- Demographic
- Analysis
  - Each Use Case
  - Overall Experience
    - Comics in General
    - Recommend
Demographics (N=41/49)
Demographics (N=41/49)

- Prior experience in course:
  - Retake: 25
  - First time: 16

- Prior experience in programming:
  - No experience: 15
  - Some (several hours/days): 10
  - Much (several weeks/months): 5

- Prior interest in programming:
  - Not interested: 20
  - Interested to a certain degree: 15
  - Highly interested: 5

- Prior perceived difficulty:
  - Easy: 5
  - Manageable: 10
  - Difficult: 25
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)

![Box plot showing the distribution of student ratings ranging from 1 to 7, with a median score of 5 and a high rating of 7.](image)
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”

"How do you feel about being introduced to concepts with comics?"
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

"How do you feel about being introduced to concepts with comics?"
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

"How do you feel about being introduced to code with comics?"
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?

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

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

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

- 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?

A. 0
B. 3
C. 4
D. 5
E. 6

- 86%

lilypad[?]
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
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
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