Creating Tutorial Materials as Lecture Supplements by Integrating Drawing Tablet and Video Capturing/Sharing

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Challenges of Undergraduate Teaching

1. ***complex computational thinking***: ***limited prior exposure*** ***large class size***
   - e.g., OOP: class associations and loops [paper]
   - e.g., OOP: **polymorphic** collection and **dynamic** binding [talk]
2. ***weekly laboratories***: ***lectures $\nrightarrow$ pre-requisites***
   - Lab assignment are important opportunities for students to achieve the intended *learning outcomes* .
   - Instructors should provide **in-depth remarks** and **illustrations** on examples, reflecting their *insights into the subjects* , but . . .
     - fixed lecture hours $\nrightarrow$ **logical** decomposition of topics
     - limited lecture hours $\nrightarrow$ **thorough**, **uninterrupted** discussion

How to Help this Frustrated Student?

Frustrated Student:
I ***did attend*** classes
but ***could not complete the weekly lab assignments***.

Motivating Question

How can we make the

in-depth and thorough ***illustrations*** *accessible* to students

for their ***self-paced study*** outside the classroom

so as to help them complete the **lab assignments**?

Contribution:
Creating Effective Tutorials on Complex Ideas

A technique for

- ***Recording illustrations*** of ***complex ideas*** on a *drawing tablet* .
  - **Pre-recording** preparation of *starter artifacts*
    (e.g., code fragments, diagrams)
  - **Frequent** and **heavyweight** *annotations*
- Allowing students to *study* outside class at their **own pace**

Let's illustrate the technique using a short **tutorial** on **polymorphism** and **dynamic binding** in OOP.

Demo Tutorial: Recall from Last Tutorial (1)

```
class Course {
 private String title;
 private double fee;

 Course(String title, double fee) {
  this.title = title;
  this.fee = fee;
 }

 String getTitle() {
  return this.title;
 }

 double getFee() {
  return this.fee;
 }
}
```

Demo Tutorial: Recall from Last Tutorial (2)

```
class Student {
 private String name;
 private Course[] courses;
 private int noc; /* number of courses */

 Student(String name) {
  this.name = name; this.courses = new Course[10];
 }

 String getName() { return this.name; }

 void register(Course c) { this.courses[noc] = c; this.noc ++; }

 double getTuition() {
  double base = 0;
  for(int i = 0; i < noc; i ++) {
   base += this.courses[i].getFee();
  }
  return base;
 }
}
```

Demo Tutorial: Recall from Last Tutorial (3)

```
class ResidentStudent extends Student {
 ResidentStudent(String name) {
  super(name);
 }

 private double premiumRate;

 double getPremiumRate() {
  return this.premiumRate;
 }

 void setPremiumRate(double r) {
  this.premiumRate = r;
 }

 double getTuition() {
  double base = super.getTuition();
  return base * premiumRate;
 }
}
```

Demo Tutorial: Recall from Last Tutorial (4)

```
class NonResidentStudent extends Student {
  NonResidentStudent(String name) {
    super(name);
  }

  private double discountRate;

  double getDiscountRate() {
    return this.discountRate;
  }

  void setDiscountRate(double r) {
    this.discountRate = r;
  }

  double getTuition() {
    double base = super.getTuition();
    return base * discountRate;
  }
}
```

Demo Tutorial: Recall from Last Tutorial (5)

```
class StudentManagementSystem {
  Student[] students;
  int nos; /* number of students */

  public StudentManagementSystem() {
    students = new Student[10000];
  }

  void add(Student s) {
    this.students[this.nos] = s;
    this.nos ++;
  }

  Student[] getStudents() {
    Student[] ss = new Student[this.nos];
    for(int i = 0; i < this.nos; i ++) { ss[i] = this.students[i]; }
    return ss;
  }
}
```

Demo Tutorial: Console Tester

```
1  public class SMSTester {
2    public static void main(String[] args) {
3      Course eecs2030 = new Course("Advanced OOP", 1000.0);
4      Course eecs3311 = new Course("Software Design", 1000.0);
5      ResidentStudent heeyeon = new ResidentStudent("Heeyeon");
6      heeyeon.setPremiumRate(1.25);
7      heeyeon.register(eecs2030);
8      heeyeon.register(eecs3311);
9      NonResidentStudent jiyoon = new NonResidentStudent("Jiyoon");
10     jiyoon.setDiscountRate(0.75);
11     jiyoon.register(eecs2030);
12     jiyoon.register(eecs3311);
13     StudentManagementSystem sms = new StudentManagementSystem();
14     sms.add(heeyeon);
15     sms.add(jiyoon);
16   }
17 }
```

Exercise 1: How do **L14** & **L15** result in a ***polymorphic*** array.

Exercise 2: Add code to output the ***tuition due*** for students.

Demo Tutorial: Expected Console Output

- Let's first see how the expected output look like!

```
Heeyeon should pay $2500.0
Jiyoon should pay $1500.0
```

- Given:

```
class StudentManagementSystem {
  Student[] students;
  ...
}
```

How can our code ensure that the tuition of:

- 1st ***resident*** student is calculated using ***premium*** rate.
- 2nd ***non-resident*** student is calculated using ***discount*** rate.

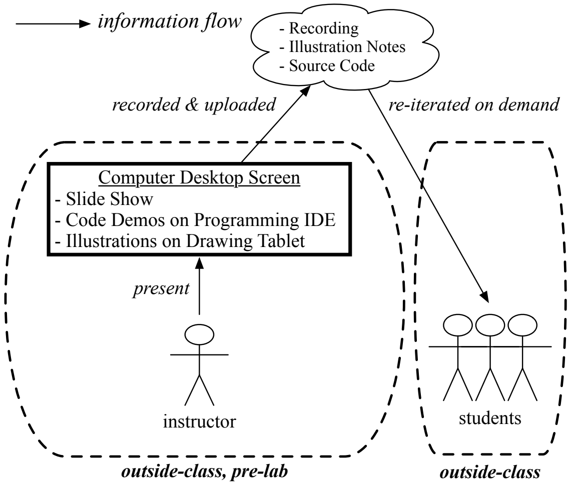
- Let's code this up!

A Pattern for Tutoring Complex Ideas

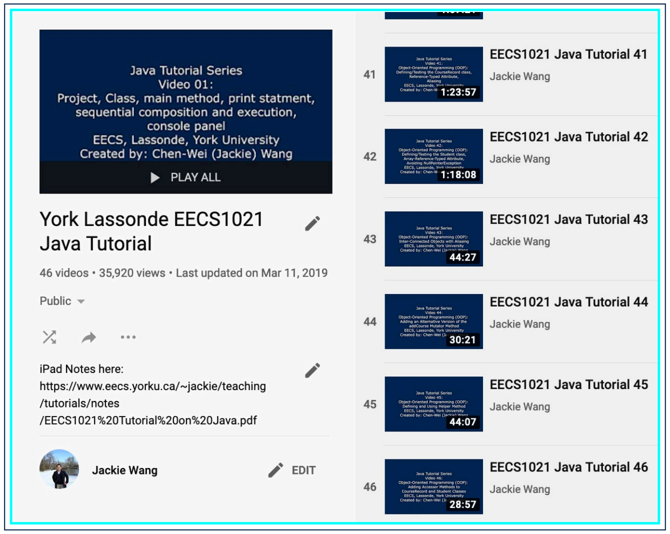
- I just demonstrated a *tutoring pattern*, choreographing:
  - ***Specify*** **the Problem**: Slide Show and/or Programming IDE
  - ***Sketch*** **the Solution**: Drawing Tablet
  - ***Develop*** **the Solution**: Programming IDE
  - ***Discuss*** **the Solution**: Drawing Tablet
- When the *drawing tablet* is used:

  Annotate on starter pages to explain ***critical steps*** in the solution.
  e.g., **starter** page vs. ***annotated*** page in the example lecture
- More examples:
  - Paper: teaching an OO programming pattern using primitive arrays
  - My lectures page (with links to various tutorials):
    `https://www.eecs.yorku.ca/~jackie/teaching/lectures/index.html`

Contribution: An Approach for Creating Effective Tutorials



Study Resources: Video Playlist



Java Tutorial Series
Video 01:
Project, Class, main method, print statment,
sequential composition and execution,
console panel
EECS, Lassonde, York University
Created by: Chen-Wei (Jackie) Wang

York Lassonde EECS1021 Java Tutorial

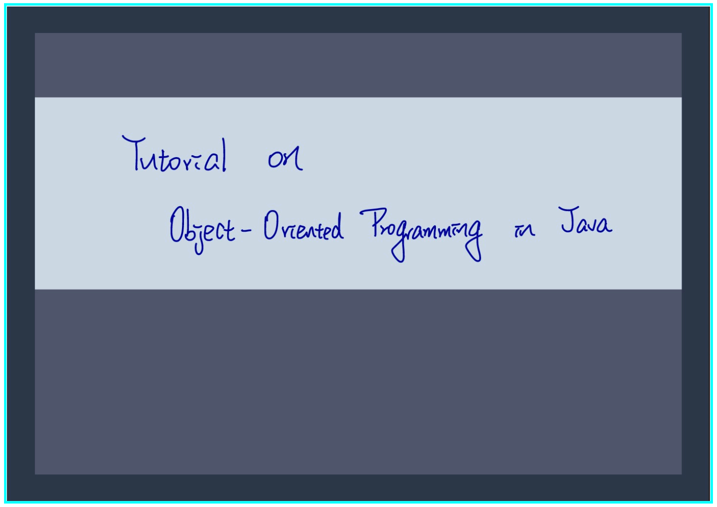
46 videos • 35,920 views • Last updated on Mar 11, 2019

iPad Notes here:
https://www.eecs.yorku.ca/~jackie/teaching/tutorials/notes/EECS1021%20Tutorial%20on%20Java.pdf

Jackie Wang

41	1:23:57	EECS1021 Java Tutorial 41	Jackie Wang
42	1:18:08	EECS1021 Java Tutorial 42	Jackie Wang
43	44:27	EECS1021 Java Tutorial 43	Jackie Wang
44	30:21	EECS1021 Java Tutorial 44	Jackie Wang
45	44:07	EECS1021 Java Tutorial 45	Jackie Wang
46	28:57	EECS1021 Java Tutorial 46	Jackie Wang

Study Resources: iPad Notes



Tutorial on
Object-Oriented Programming in Java

Teaching Context

Proposed approach adopted in *undergraduate teaching*:

- *7 iterations* of four courses [1st-, 2nd-, 3rd-year]
- Created *12* series of *148* tutorial videos (≈ *59.5* hours)
- Tutored ***1,295 students***

- e.g., ***Java Programming from Scratch***
  - variables, assignments [**data flow**]
  - if-statements, loops, arrays [**control flow**]
  - classes, attributes, methods, objects, aliasing [**basic OOP**]
- e.g., ***OOP for Developing Android Mobile Apps***
  - Model-View-Controller
- e.g., ***Developing a Birthday Book Application in Java***
  - multiple classes
  - complex loops

Nonetheless, the proposed approach is *sufficiently general* for tutoring any ***complex idea***.

Reflections

- Instructor's Efforts

  Starter Pages: What concepts/examples should be illustrated?

- Drawing Tablet vs. **Blackboard/Whiteboard**
  - ***Time Effectiveness***: Starter pages let us get straight to the point.
  - ***Reusability***: Starter pages may be elaborated and reused.

- Drawing Tablet vs. **Slide Animations**

  Flexibility: ***Dynamic*** control of the pace and level of details w.r.t. the ***comprehension level***.

  e.g., *starter* page vs. *annotated* page in the example lecture

- Review of Tutorials

  Repetition: Even effective illustrations take repetitions to achieve ***full comprehension***.

Beyond this talk. . .

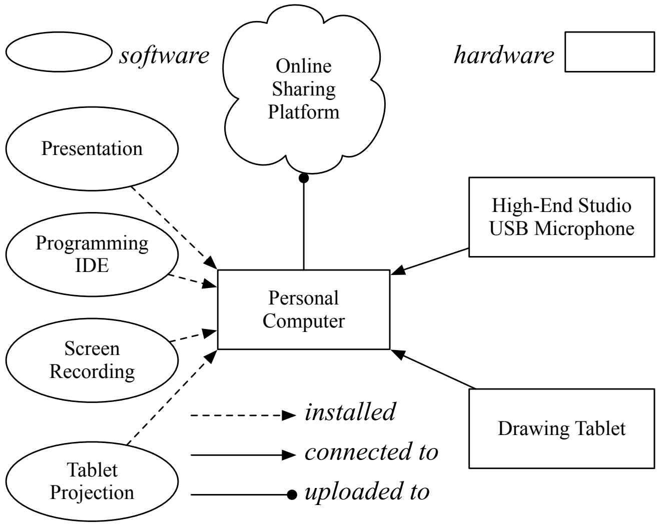
- Read my paper!
  - Adopting the Approach
  - Evaluation: Students' Perception
  - Evaluation: Improvement on Students' Performance
  - Comparison with Related Works
- Similar approach adopted for delivering *effective lectures*:

  Chen-Wei Wang. ***Integrating Drawing Tablet and Video Capturing/Sharing to Facilitate Student Learning***. In *ACM Computing Education (**CompEd**)*, 2019. Chengdu, China.

Questions?

Teaching Challenge: Big Classes

Adopting the Approach



software

hardware

Online Sharing Platform

Presentation

Programming IDE

Screen Recording

Tablet Projection

Personal Computer

High-End Studio USB Microphone

Drawing Tablet

installed

connected to

uploaded to

Index (1)

Index (2)