

**Teaching by Design (TbD)
through
Cognitive Tutors
for the adult learners**

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Open University Malaysia

Online Learning



Online Teaching



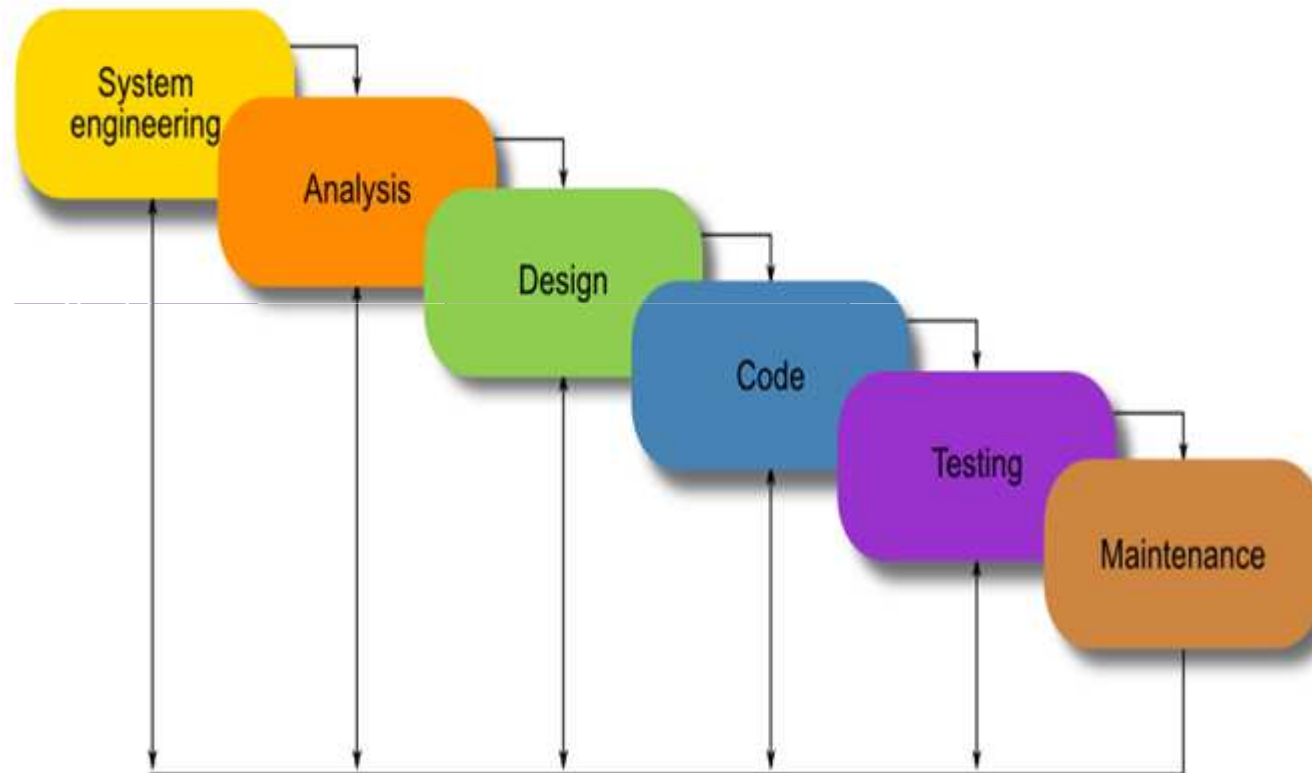
Designing the **online teaching** is very important in order to make the **online learning** more **effective** and **engaging**

Can we **design** our **online teaching**?
Yes, we can....



Teaching by design

Waterfall model



Find Cool Activities
to Use in the Class

Figure out How to
Teach and Grade
Activities

Align Activities to
the Standards and
Core Curriculum

Traditional Lesson Planning

Understand the
Standards and
Core Curriculum

Plan for Students'
Learning and
Understanding

Develop Cool Activities to
Use in the Class that Stay
with the Student
FOREVER!

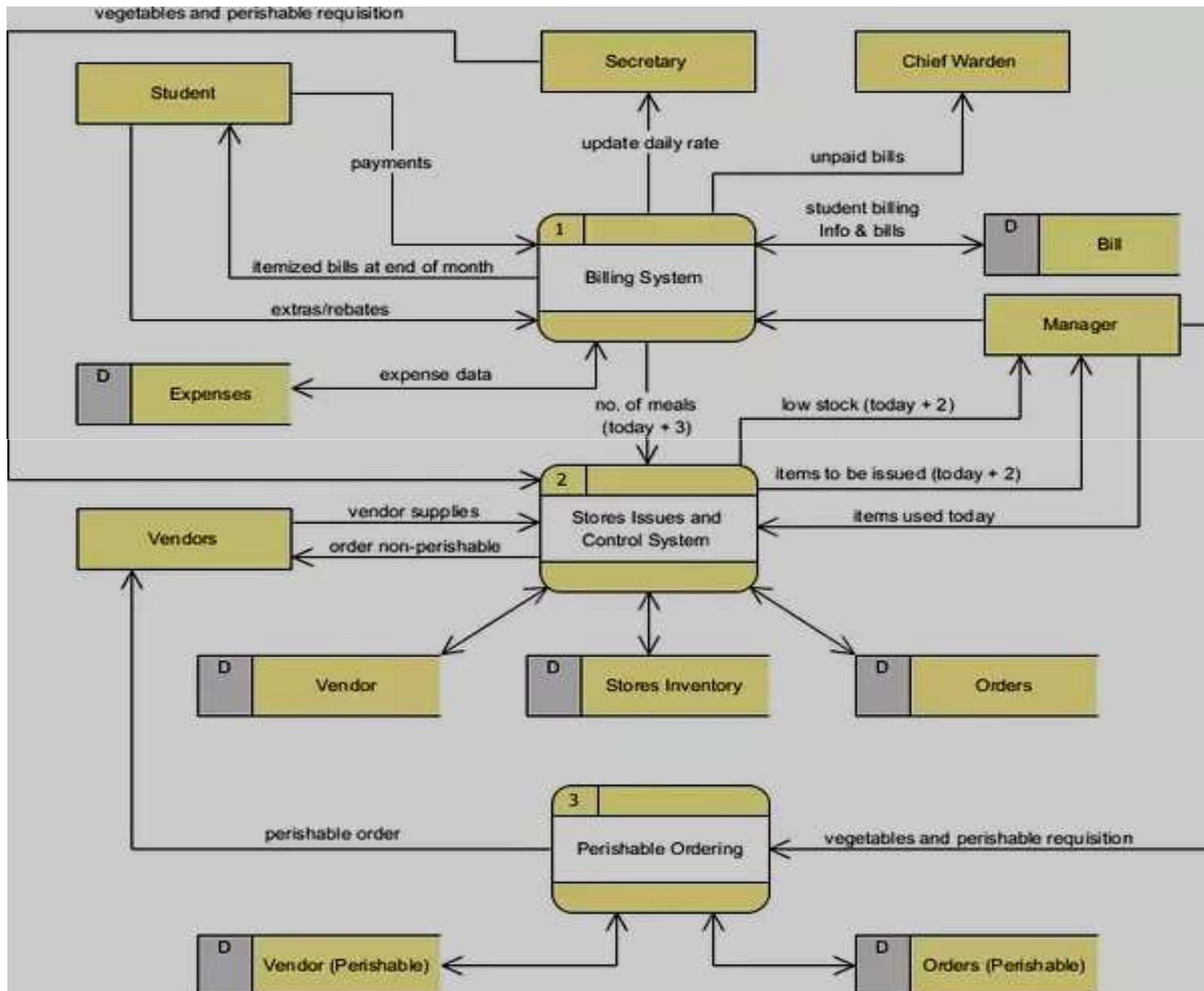
Teaching by Design



Instrument/Tool/Template for Backward Design?











DFD - Data Flow Diagram



TbD template

Wiggins, G., & McTighe, J. (2005). Understanding by design. Association for Supervision and Curriculum Development

Stage 1- Desired Results	
Established Goals: 	
Understandings: 	Essential Questions: 
Students will know... 	Students will be able to ... 
Stage 2- Assessment Evidence	
Performance Tasks: 	Other Evidence: 
Stage 3- Learning Plan	
Learning Activities: 	



Stage 1- Desired Results	
Established Goals: <ul style="list-style-type: none"> What relevant goals (e.g., content standards, course or program objectives, learning outcomes) will this design address? 	
Understandings: Students will understand that... <ul style="list-style-type: none"> What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable? 	Essential Questions: <ul style="list-style-type: none"> What provocative questions will foster inquiry, understanding, and transfer of learning?
Students will know... <ul style="list-style-type: none"> What key knowledge will students acquire as a result of this unit? Think in terms of nouns and in terms of content 	Students will be able to ... <ul style="list-style-type: none"> What key skills will students acquire as a result of this unit? Think in terms of verbs.
Stage 2- Assessment Evidence	
Performance Tasks: <ul style="list-style-type: none"> Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understandings be judged? 	Other Evidence: <ul style="list-style-type: none"> Through what other evidence (e.g., quizzes, tests, academic prompts, observations, homework, journals) will students demonstrate achievement of desired results? How will students reflect upon and self-assess their learning?
Stage 3- Learning Plan	
Learning Activities: What learning experiences and instruction will enable students to achieve the desired results? How will the design	
<ul style="list-style-type: none"> W= Help students to know Where the unit is going and What is expected? Help the teacher know Where the students are coming from (prior knowledge, interests)? H= Hook all students and Hold their interest? E= Equip students, help them Experience the key ideas and Explore the issues? R= Provide opportunities to Rethink and Revise their understandings and work? E= Allow students to Evaluate their work and its implications? T= Be Tailored (personalized) to the different needs, interests, and abilities of learners? O= Be Organized to maximize initial and sustained engagement as well as effective learning? 	

G

U

Q

K

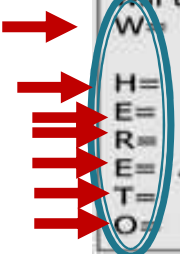
S

T

OE



L



Design questions for each element of the phases

Wiggins, G., & McTighe, J. (2005). Understanding by design. Association for Supervision and Curriculum Development

- ▶ Example of a completed **TbD** plan for one of the lessons (**Lesson 6**) will be shown
- ▶ Subject: **Java Programming**
- ▶ Type of students: **Adult Learners** (*part-time study*)

STAGE 1 – DESIRED RESULTS

Unit Title : Object-oriented Programming I
Established Goals: Develop object-oriented programs (CLO4) **G**

<p>Understandings: Students will understand that:</p> <ul style="list-style-type: none"> Java provides excellent "platform" to solve real-world problems via class programs <p style="text-align: right;">U</p>	<p>Essential Questions:</p> <ul style="list-style-type: none"> What is class and how it differs from the object? How a class program differs from a normal Java program? How class is declared in Java? How a class is modeled and finally, implemented? <p style="text-align: right;">Q</p>
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<p>Students will know:</p> <ul style="list-style-type: none"> How to declare a class program The main components that make-up a class How to convert a requirement into a class model <p style="text-align: right;">K</p>	<p>Students will be able to:</p> <ul style="list-style-type: none"> Develop class program in Java for any given problems or scenarios <p style="text-align: right;">S</p>
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STAGE 2 – ASSESSMENT EVIDENCE

<p>Performance Tasks:</p> <ol style="list-style-type: none"> Formative assignment: Student to develop a class program for a given scenario <p style="text-align: right;">T</p>	<p>Other Evidence:</p> <ol style="list-style-type: none"> Pre-Test questions H Post-test questions with feedback R <p style="text-align: right;">OE</p>
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STAGE 3 – LEARNING PLAN

Learning Activities via COGNITIVE TUTOR (CT6): **O** **T**

- Students will be explained on the nature of the previous Java programs. **W**
- To explain the advantages of object-oriented programs
 Spark: ask the student which is created first: object or class **H**
- The concept of class and object will be introduced in an analogous manner:
- Introduce the concept of object and class
- Explain the elements of class
- The concept of class and object will be introduced via Java
- A problem will be presented and students
 Spark: Ask the student about the number of states and behaviors in the given problem **H**
 To teach students on how to discover the main elements of a class
- Student will solve a programming problem for a given problem/scenario
- Explain to the student that class can't be executed and to give the rationale **R**
- To give overview about "object" which will be the next topic of discussion and how it is related to the current topic on class **W**

E
E
E
E
E
E



The course has the following learning outcomes (LO):

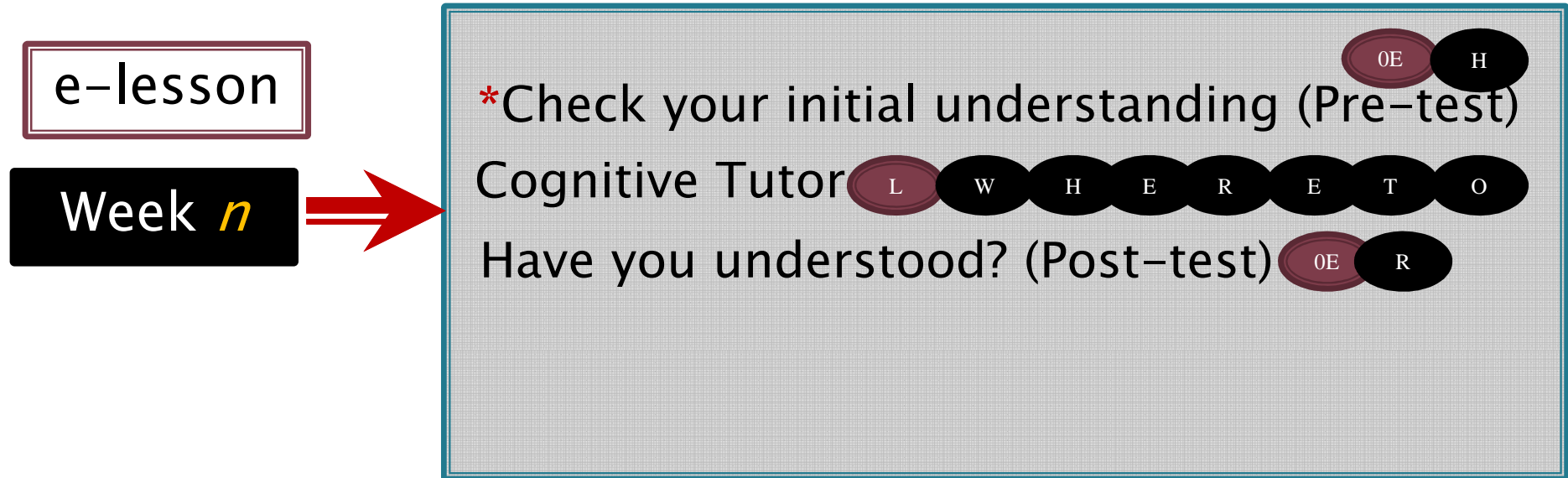
LEARNING OUTCOME (LO)	MOE LO Domains
LO1: Explain basic constructs of Java	Knowledge
LO2: Develop Java programs using basic programming constructs	Scientific Methods, Critical Thinking and Problem Solving Skills
LO3: Develop Java programs using object-oriented approach	
LO4: Develop GUI-based programs using Java	

The SEVEN cognitive tutors that I had developed support **LO2** and **LO3** of the subject. The details of each of these cognitive tutors are given below:

Application	Programming Concept Covered	LO	Skills	Student Learning Time (SLT)
Cognitive Tutor I	Basic Constructs of Java	LO2	Cognitive	1.5 hours
Cognitive Tutor II	if-else selection structure	LO2	Cognitive	2.0 hours
Cognitive Tutor III	for-loop	LO2	Cognitive	1.5 hours
Cognitive Tutor IV	while-loop	LO2	Cognitive	1.5 hours
Cognitive Tutor V	Array	LO2	Cognitive	1.5 hours
Cognitive Tutor VI	Writing class programs	LO3	Cognitive	1.7 hours
Cognitive Tutor VII	Creating objects	LO3	Cognitive	1.5 hours

Implementation

Online Teaching via TbD



Week *n*

Week 1 (Tutorial 1)



Your Learning Hours: 4 hours

Learning Outcome: At the end of the session, you should be able to:

- write Java programs using basic operators and operand
- able to compile and execute a Java program

What are you learning: Topic 1

Prerequisite: None

Spark: Ever wonder how to write Java programs? Java is fun and easy to learn

WHAT YOU NEED TO DO:

1. Check your initial understanding of the contents by doing the self-assessment quiz
2. Interact with Dr Nantha in order to solve the problem given below.

write a Java program that will read TWO integer marks from the user.
Then, the program will determine and display the average marks.

3. Participate in the discussion
4. Check whether you have understood the contents by doing the self-assessment quiz

Material that will help you in this activity:

- E-Module **CBOP3203 (OBJECT-ORIENTED PROGRAMMING)** (Topic1)

Instruction
& contextual
information

Activity

Pre-test

Cognitive Tutor

Post-test



Check Your Initial Understanding (W1)!

OE

H

This is self-assessment questions that must be completed in order to interact with Dr Nantha



Interact with Dr. Nantha

Cognitive Tutor

L

W

H

E

R

E

T

O

Restricted

Not available unless: You achieve a required score in Check Your Initial Understanding (W1)!



Discussion Forum

Restricted

Not available unless: You achieve a required score in Check Your Initial Understanding (W1)!

Post your questions here (if any) after interacting with Dr. Nantha



Have you understood (W1)?

Restricted

Not available unless: You achieve a required score in Check Your Initial Understanding (W1)!

OE

R

Implementation via LMS

Demo: Actual Implementation

The screenshot displays a web browser window with the URL `inspire.oum.edu.my/course/view.php?id=379`. The browser tabs include 'Cari', 'Staff Portal', 'Inbox (19,117) - nanthaku...', and 'Course: Object-oriented Pr...'. The user is logged in as 'Dr Nantha Kumar Subramaniam nanthakumar'.

Course Information:

- Course ID: CBOP3203
- Participants
- Badges
- Competencies
- Grades
- Course Announcement (Current)
- E-Module
- Assignment
- General Forum
- Virtual Classroom
- e-Lesson Area
- Week 1 (basics of Java)
- Week 2 (if-else selection structure)
- Week 3 (Part 1) (for-loop)
- Week 3 (Part 2) (while loop)
- Week 4 (array)

e-Lesson Area

Week 1 (basics of Java)

Your Learning Hours: 4 hours

Learning Outcome: At the end of the session, you should be able to:

- write Java programs using basic operators and operand
- able to compile and execute a Java program

What are you learning: Topic 1

Prerequisite: None

Spark: Ever wonder how to write Java programs? Java is fun and easy to learn

WHAT YOU NEED TO DO:

1. Check your initial understanding of the contents by doing the self-assessment quiz

RECENT ACTIVITY

Activity since Wednesday, 27 June 2018, 3:48 PM

[Full report of recent activity...](#)

No recent activity

Cognitive Tutors (CT)

A cognitive tutor is a tutoring system that coach the students and utilizes a cognitive model to provide feedback to students as they are working through problems. This feedback will immediately inform students of the correctness, or incorrectness, of their actions

CT1

CT2

CT3

CT4

CT5

CT6

CT7

Cognitive Tutor-Lesson 6

LESSON 6: Developing class programs (CODE: L6)
PRE-REQUISITE: Lesson 1 - Lesson 4 (L1-L4)
PROBLEM TO SOLVE:
Develop a class program called Product that will determine the total price that need to be paid for a product purchased by a client based on the prize per unit and quantity purchased. The class shall display the total amount that need to be paid as well as the product name. The class also can change the product name and set initial value for some of the data fields.

Click here to start the interaction

##Work Area

##Chat Area

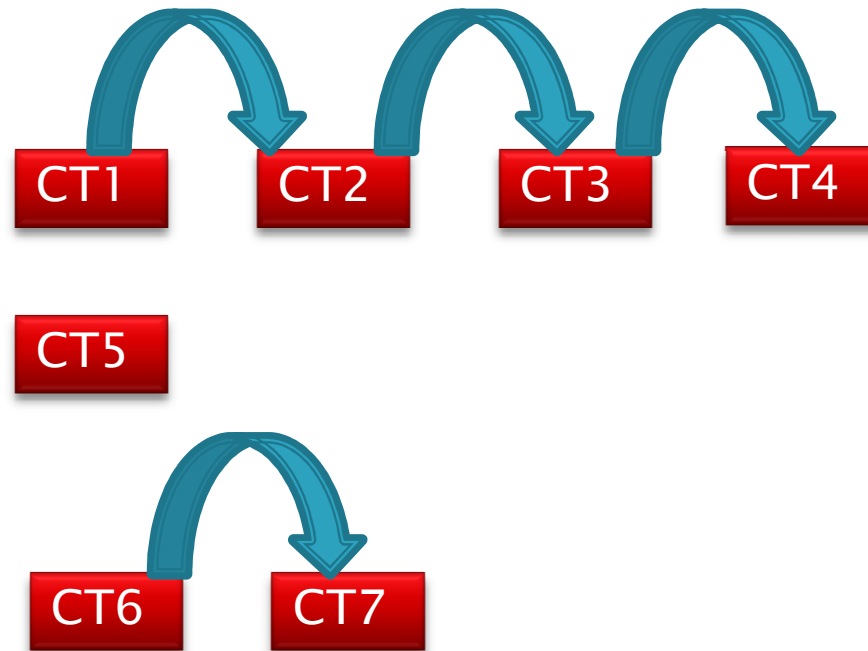
Run View Program Resume the interaction...

Select your message: Submit

9:14 AM
29/6/2018

Features & Uniqueness

- ▶ Support human-like interactive dialog
- ▶ Running conversation, complete with probing questions, positive and negative feedback, follow-up questions and requests for explanation
- ▶ Learners actively construct knowledge through conversation with the CTs in order to solve a programming problem in the “one-to-one” session of the problem-solving process for more than 1 hour.
- ▶ The cognitive tutors also support animated-based explanation and visualizations



Most of CTs are built-up from the previous lessons

Constructivism: Meaning cannot be taught; it must be fashioned by the learner via artful design and effective coaching by the teacher

Demo 1a: Student initiating the interaction and the cognitive tutor greets the students



The screenshot shows a window titled "Cognitive Tutor-Lesson 6". The main content area is divided into two sections. The top section contains the following text:

LESSON 6: Developing class programs (CODE: L6)
PRE-REQUISITE: Lesson 1 - Lesson 4 (L1-L4)
PROBLEM TO SOLVE:
Develop a class program called Product that will determine the total prize that need to be paid for a product purchased by a client based on the prize per unit and quantity purchased. The class shall display the total amount that need to be paid as well as the product name. The class also can change the product name and set initial value for some of the data fields.

To the right of this text is a button labeled "Click here to start the interaction".

The bottom section of the window is split into two panes: "##Work Area" on the left and "##Chat Area" on the right. Both panes are currently empty.

At the bottom of the window, there are three buttons: "Run", "View Program", and "Resume the interaction..". Below these buttons is a text input field labeled "Select your message:" followed by a "Submit" button.

Demo 1b: Student can interact with the cognitive tutor by typing a message or selecting the correct options presented by the cognitive tutor



LESSON 7: Creating objects from a class program (CODE: L7)
PRE-REQUISITE: Lesson 6 (L6)

PROBLEM TO SOLVE:
In the previous lesson (L6), you developed the class Product.
In this lesson, we will create the object of this class

[Click here to start the interaction](#)

Syntax to create an object

<Class Name> <Object Name> = new

Constructor is called created

Dr Nantha>> It is important for you to have a clear understanding on the meaning of object and how it is derived from the class

Dr Nantha>> Now let us focus on the relationship of object with class

Dr Nantha>> Pls click the link given on the left. Once you have done, click the "Resume the interaction.." button to resume the interaction with me

Dr Nantha>> You have learned the relationship between object and class

Dr Nantha>> In the previous lesson, you had developed the class program and now you will learn on how to create the object

Dr Nantha>> But before that, I will teach you the syntax to create the object

Dr Nantha>> Pls click the link given on the left to learn on how to create an object from a class

Dr Nantha>> Once you have done, click the "Resume the interaction.." button to resume the interaction with me

Dr Nantha>> I hope you have learned the syntax to create the objects

Dr Nantha>> Take note that multiple objects can be created from a single class

Dr Nantha>> Now let us see an complete example in which an object is created from a class

Dr Nantha>> Once you have done, click the "Resume the interaction.." button to resume the interaction with me

Dr Nantha>> You know that class's constructor will be called when an object is created

Run the above program View class Product Resume the interaction..

Type your message:

11:24 AM
30/7/2018

Demo 2: Student can interact with the cognitive tutor by typing a message or selecting the correct options presented by the cognitive tutor



LESSON 6: Developing class programs (CODE: L6)
PRE-REQUISITE: Lesson 1 - Lesson 4 (L1-L4)
PROBLEM TO SOLVE:
Develop a class program called Product that will determine the total prize that need to be paid for a product purchased by a client based on the prize per unit and quantity purchased. The class shall display the total amount that need to be paid as well as the product name. The class also can change the product name and set initial value for some of the data fields.

[Click here to start the interaction](#)

##Work Area

```
...Chat Area--Connected++  
Dr Nantha>> Hi! How are you? We are meeting again in an IMPORTANT new lesson  
Dr Nantha>> Make sure that you have gone through all the previous lessons before embarking on this lesson :)  
Dr Nantha>> In the previous lessons, we have written Java programs in a structured approach  
Dr Nantha>> Now, we will write Java programs using object-oriented approach (OOP) that had made Java so popular  
Dr Nantha>> OOP-based programs are easy to maintain, reuse and provide many design benefits  
Dr Nantha>> In OOP, TWO basic constructs are "class" and "object" and there are inseparable  
Dr Nantha>> FYI, class and objects are the backbone of Java  
###Tutor is typing a message. Pls wait
```

Run View Program Resume the interaction..

Select your message: Submit

7:26 AM 29/6/2018

Demo 3: CT will present the difficult concept via interactive animated images



The screenshot shows a window titled "Cognitive Tutor-Lesson 6". The main content area is divided into two sections. The top section contains the following text:

LESSON 6: Developing class programs (CODE: L6)
PRE-REQUISITE: Lesson 1 - Lesson 4 (L1-L4)
PROBLEM TO SOLVE:
Develop a class program called Product that will determine the total prize that need to be paid for a product purchased by a client based on the prize per unit and quantity purchased. The class shall display the total amount that need to be paid as well as the product name. The class also can change the product name and set initial value for some of the data fields.

Below this text is a button labeled "Click here to start the interaction".

The bottom section of the window contains a chat log with the following messages:

[Click here to learn about class and object](#)

Dr Nantha>> opps...you did not provide the answer

Dr Nantha>> Actually, we need to create the class first, not the object

Dr Nantha>> in OOP, class is the most fundamental element. We need to create the class first before the object can be created

Dr Nantha>> FYI, object is created from the class

Dr Nantha>> In other words, object is an instance of the class

Dr Nantha>> We will explore on this in a short while

Dr Nantha>> It is important for you to have a clear understanding on the meaning of class and object in OOP

Dr Nantha>> Now let us focus on class and object in detail

Dr Nantha>> Pls click the link given on the left. Once you have done, click the "Resume the interaction.." button to resume the interaction with me

At the bottom of the window, there are three buttons: "Run", "View Program", and "Resume the interaction..". To the right of these buttons is a text input field labeled "Select your message:" and a "Submit" button.

Demo 4: CT supports programs simulation

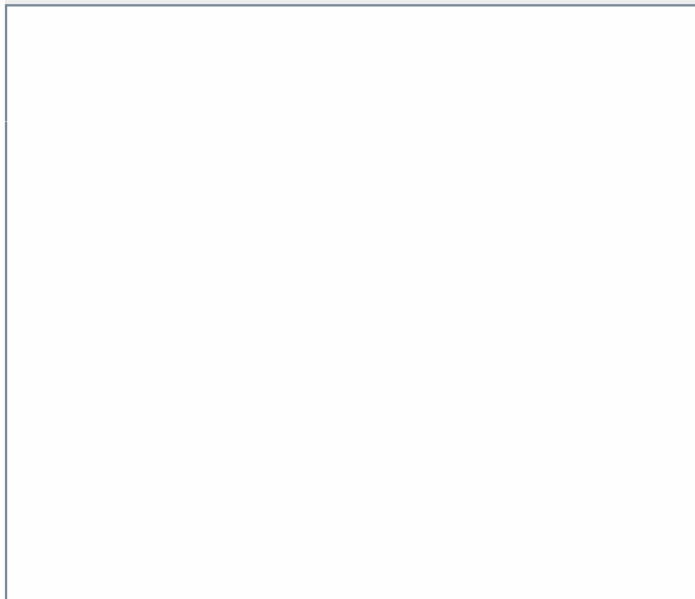


LESSON 2: USING "IF-ELSE" STATEMENT IN JAVA (CODE: L2)
PRE-REQUISITE: LESSON 1 (L1)

PROBLEM TO SOLVE:
Write a Java program that will display a grade based on the following criteria:

Marks more than or equal to 60: Grade A
Marks between 40-59 (inclusive): Grade B
Marks less than 40: Grade C

[Click here to start the interaction](#)



```
...Chat Area--Connected++  
Dr Nantha>> Congrats..you have successfully completed the lesson..  
Dr Nantha>> By now you should be able to write Java programs by using if-else selection structure  
###Tutor is typing a message. Pls wait
```

[Run](#) [View Program](#) [Output Explained via Flow Chart](#) [Resume the interaction..](#)

Select your message: [Submit](#)

Demo 5: CT supports interactive exercises



LESSON 6: Developing class programs (CODE: L6)
PRE-REQUISITE: Lesson 1 - Lesson 4 (L1-L4)
PROBLEM TO SOLVE:
Develop a class program called Product that will determine the total prize that need to be paid for a product purchased by a client based on the prize per unit and quantity purchased. The class shall display the total amount that need to be paid as well as the product name. The class also can change the product name and set initial value for some of the data fields.

[Click here to start the interaction](#)

[Click here to complete the program](#)

...Chat Area--Connected++

Dr Nantha>> Now you know that the class program for this problem has 4 states and 4 behaviours..

Dr Nantha>> And you also have seen how I have put all these elements in a proper class structure

Dr Nantha>> As stressed earlier, states will be represented by the attributes (which is the variables declared in a class) and behaviours will be implemented via the methods

Dr Nantha>> The partially completed class program for this problem will be presented to you when you click the link on the left

Dr Nantha>> Your task now is to complete the program

Dr Nantha>> Now click the link and complete the program

Dr Nantha>> Once you have completed the exercise, click the "Resume the interaction.." button in order to resume the interaction with me

Run

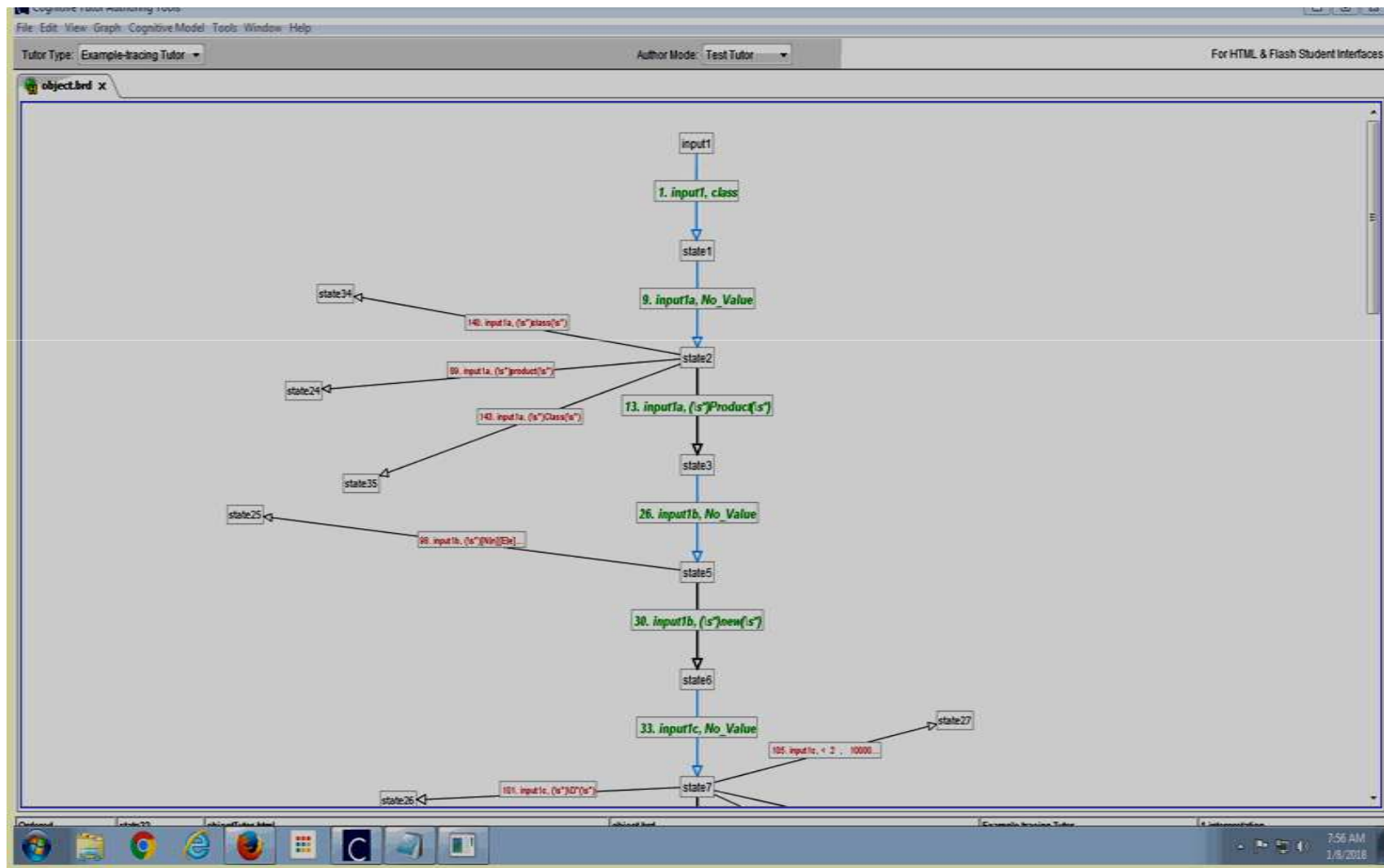
View Program

Resume the interaction..

Select your message:

Submit

behaviour graph approach in interactive exercises



Students' feedback



1: Strongly disagree
4: Strongly agree

Conclusion

- ▶ Teaching including online teaching is always “by hope” as opposed to “by design”
- ▶ Learning is activity, but unfortunately there is no meaning in the learning activity
- ▶ Meaning cannot be taught; it must be fashioned by the learner via artful design and effective coaching by the teacher
- ▶ Teachers must transform themselves as a designer
- ▶ Cognitive Tutors come handy to support TbD even for **online teaching**

Awards / Recognition

- ▶ My entry entitled "Teaching by Design through Cognitive Tutors" has been selected as the winning research for IUCEL 2017 e-Learning award under the **Best e-Learning Facilitator Award** during the 2nd International University Carnival on E-Learning 2017 (IUCEL 2017), organized by Ministry of Higher Education of Malaysia, Malaysian e-Learning Council for Public Universities and Malaysia E-Learning Centre.
- ▶ [**Finalist**] Teaching by design via Cognitive Tutors *2018 International Conference on Open and Innovative Education (ICOIE 2018)* for the *Innovative Practices Award Competition* [July 2018, Hong Kong]
- ▶ [**Finalist**] MSC-APICTA 2018 for the Education category

I hear and I forget.
I see and I remember.
I do and I understand.

Chinese proverb

Thank you...