

Computational Thinking Education in Korea

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VISION success development
project STRATEGY
from motivation leadership
action excellence planning



I ♥ BOYS

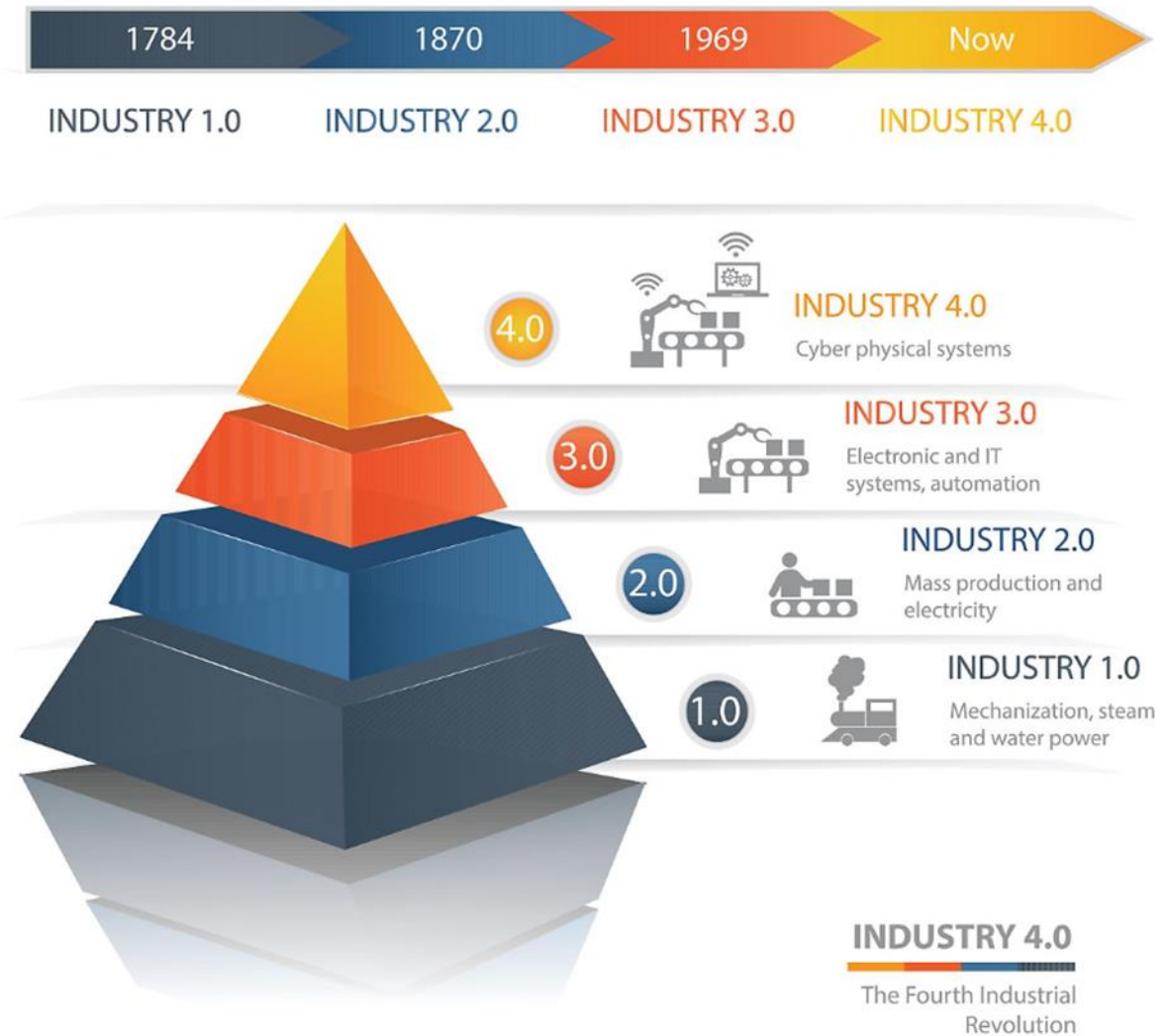
01



Why Computational Thinking?

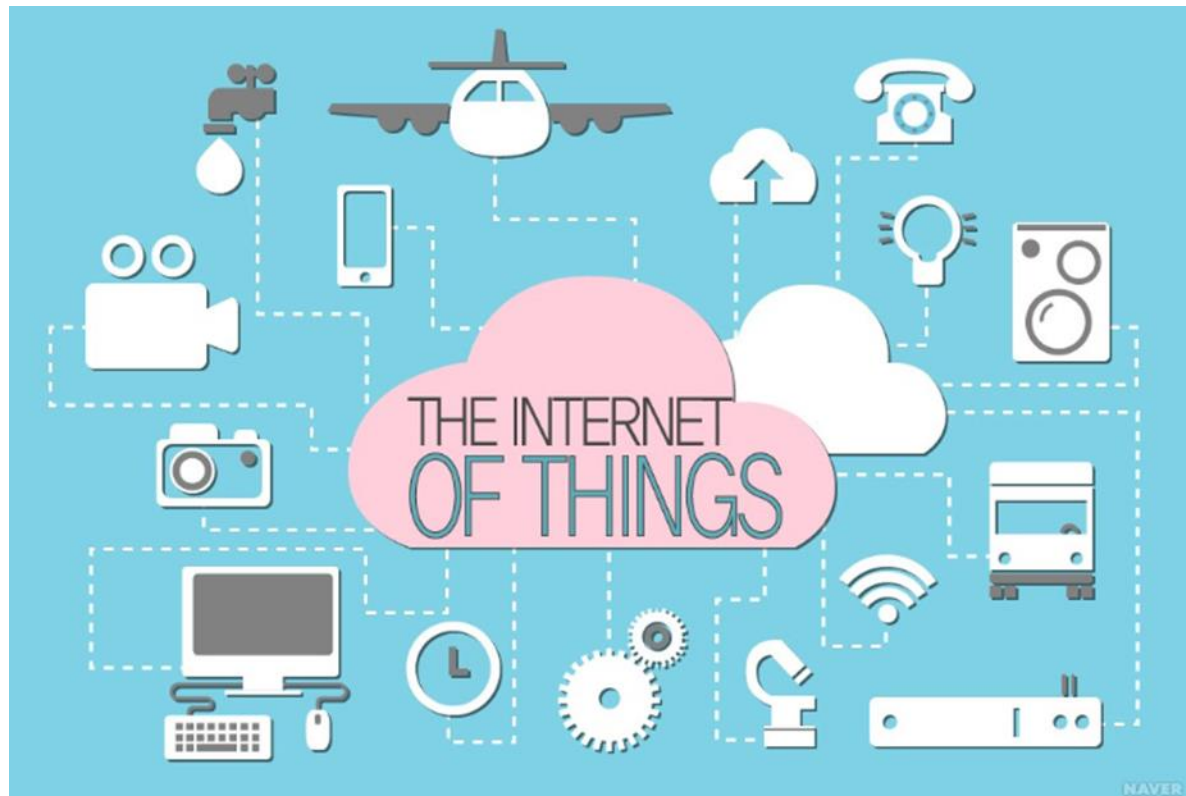
4th Industrial Revolution (Industry 4.0)

This revolution refers to an industrial change that is based on a “virtual physical system” that can intelligently control objects through a high speed network.



“virtual physical system” : IOT

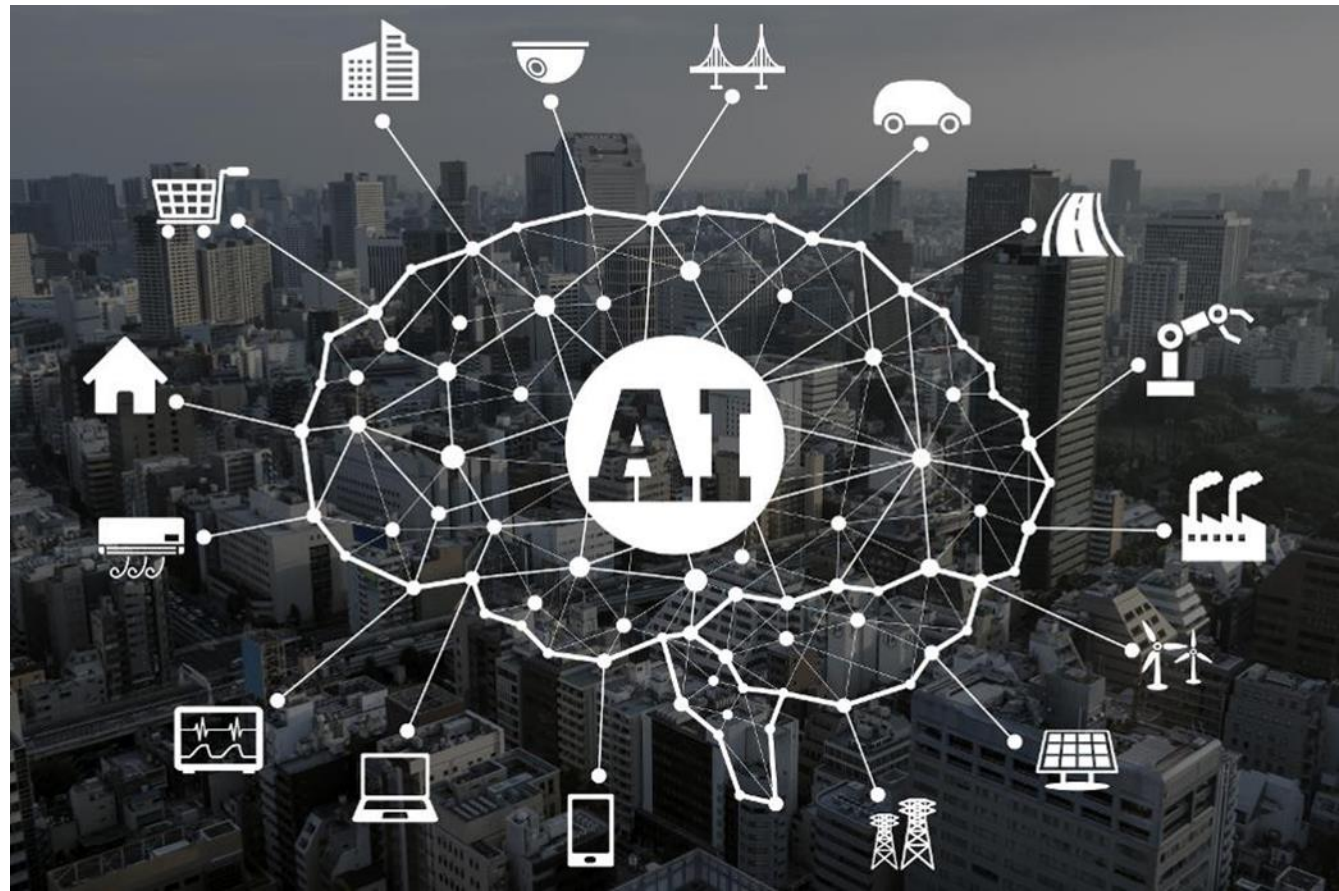
IOT(Internet of Things) refers to the connected internet system of tangible or intangible objects for providing new services that individual objects could not provide.



AI (Artificial Intelligence)

AI is “a system to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation”

Kaplan Andreas;
Michael Haenlein
(2018) Siri, **Siri** in
my Hand, who's the
Fairest in the Land?
On the
Interpretations,
Illustrations and
Implications of
Artificial Intelligence.
Business Horizons,
62(1)



Self-driving Car

A self-driving car is a vehicle that is capable of sensing its environment and moving with little or no human input. It combine a variety of sensors to perceive their surroundings to identify appropriate navigation paths, as well as obstacles and relevant signage



Virtual Reality(VR)

VR is a cutting-edge technology that allows people to experience real life in a computer-generated virtual world.

It can be used through HMD, which is a display device that is mounted on the head.

Simulation equipment training pilots to fly fighter jets

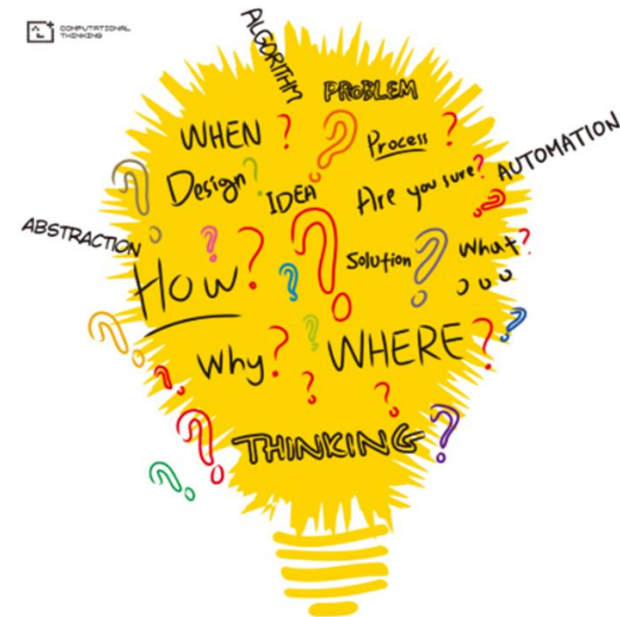


Key competencies operating “VPSs”

- The most important key competency for operating “virtual physical systems”:
 - **Computational Thinking Ability:** Competency for communicating between human and machine
- Nurturing computational thinking ability of students is essential for booming up the 4th industrial revolution.
- It should be a **goal** of education.
- Like many other countries, Korea introduces “**computational thinking**” from elementary school as compulsory.

Computational Thinking

- Computational thinking is a **problem solving process to design** some kinds of “procedure” or algorithm with or without programming language.
- How to make students think procedurally and efficiently in problem solving situations?
- Korea puts weight on algorithm with programming language.
- “Coding” from elementary school:
“Coding fever” like LOGO in 1980s and 90s.



Coding fever in Korea

We have more than hundreds of Coding Private Institutes for elementary and high school students in Seoul.



Rapid Society Change

- Industry 4.0 starts to move rapidly towards Industry 5.0 when the society begins to allow customers to customize what they want.

1.0

◆ **1780 - Mechanisation**
Industrial production based on machines powered by water and steam

2.0

◆ **1870 - Electrification**
Mass-production using assembly lines

3.0

◆ **1970 - Automation**
Automation using electronics and computers

3.5

◆ **1980 - Globalisation**
Offshoring of production to low-cost economies

4.0

◆ **Today - Digitalisation**
Introduction of connected devices, data analytics and artificial intelligence technologies to automate processes further

5.0

◆ **Future - Personalisation**
The fifth industrial revolution, or Industry 5.0, will be focused on the co-operation between man and machine, as human intelligence works in harmony with cognitive computing. By putting humans back into industrial production with collaborative robots, workers will be upskilled to provide value-added tasks in production, leading to mass customisation and personalisation for customers

Faster fish rather than big fish!!

Smart thinking rather than lots of knowledge



In the new world,
it is not the big fish
which eats the
small fish, it's the
fast fish which
eats the **slow fish**

Klaus Schwab
Founder and Executive Chairman
World Economic Forum

Cognitive Skill in Industry 4.0

- What does smart thinking mean in Industry 4.0?
- If the "change of technology" is achieved, the robots equipped with AI will be responsible for a lot of human activities.
- Instead, human beings must have the ability to support cognitive skills like critical thinking, creativity, and problem solving for the use of technology.



Soft Skill in Industry 4.0

- The 4th industrial revolution' will lead to a change in the job world.
- Lifelong learning becomes important because the speed of vocational and knowledge destruction is very rapid.
- In the new society, human soft skills such as challenging adventure and networking must become more important.



Learnability in Industry 4.0

"In the 4th Industrial Revolution, the *Learned* will be disrupted by the *Learner*. We are focussed on building *Learnability* as the core skill set for the future workforce"

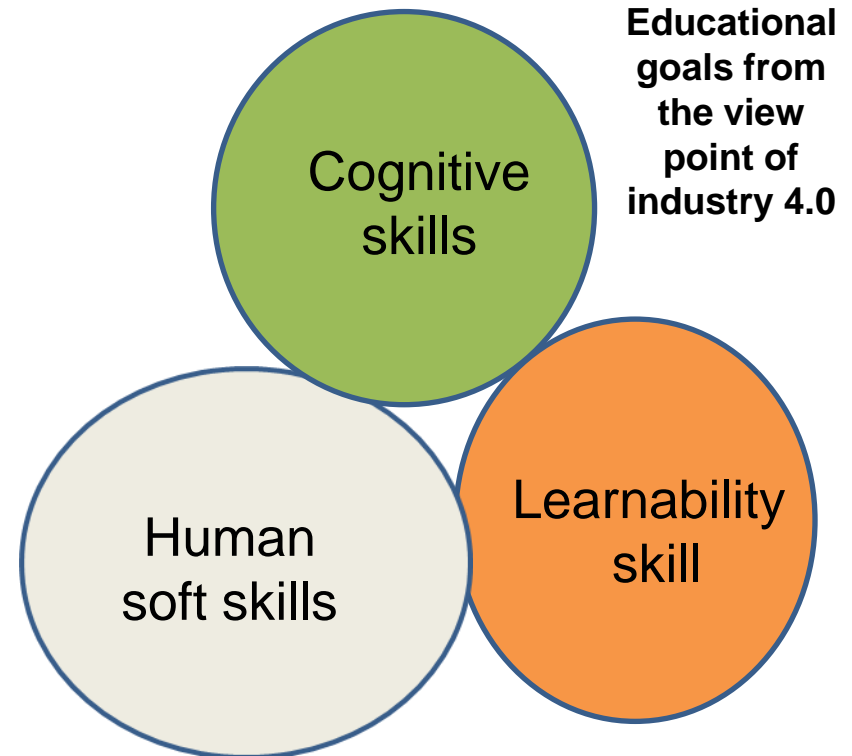
- Karl Mehta,
Founder & CEO, EdCast
@ World Economic Forum'17 in Davos.



Educational goal from the view point of Industry 4.0

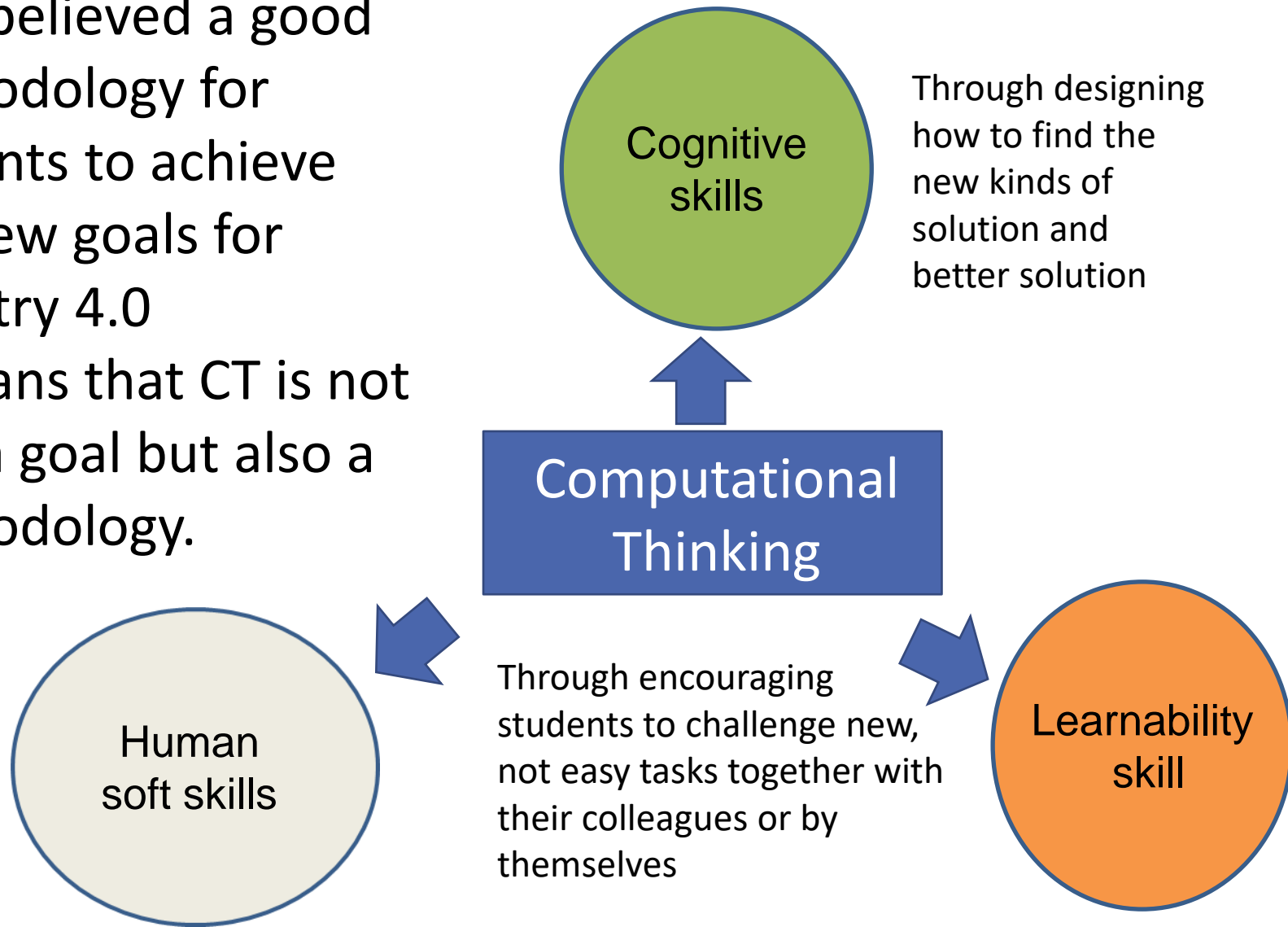
- For sustainable development of the 4th industrial revolution, the most important factor is to train students with new kinds of skills:

- Cognitive skills such as critical thinking, creativity, and problem solving
- Human soft skills such as challenging adventure and networking
- Learnability as new skill to learn from surrounding world by oneself



Computational Thinking for “New Goals”

- CT is believed a good methodology for students to achieve the new goals for Industry 4.0
- It means that CT is not only a goal but also a methodology.



Computational Thinking for “impression and meaning”

Computational thinking could make students to feel pleasure (impression) in learning and benefit of discovery, (meaning for learning) based on what teachers teach.

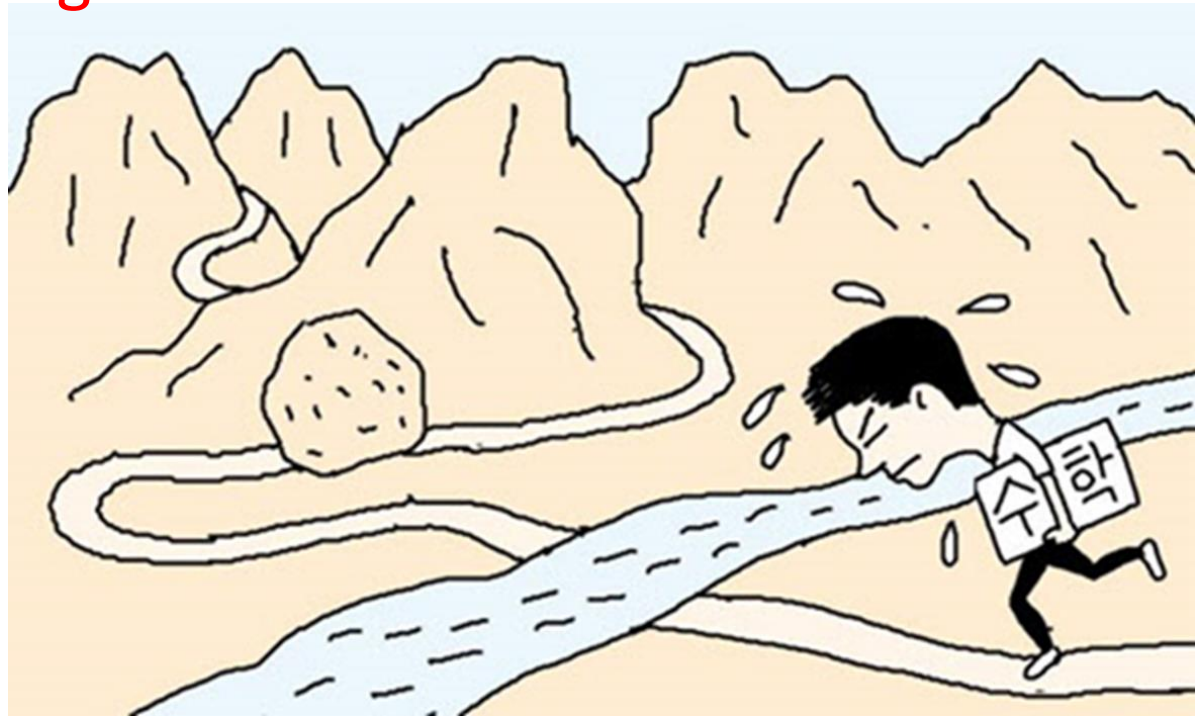
“The scandal of education is that every time you teach something, you deprive a student of the pleasure and benefit of discovery.”

Seymour Papert
born February 29, 1928
died July 31, 2016

Crisis: Few Impression and meaning

- “Crisis”: Korean students has few “impression and meaning” in their learning process.
- Students are exhausted in learning mathematics because of so much pressure in memorizing and drilling formula and skills at school and such an effort in learning does not give them any meaning.

SuPoJa: students who dislike or give-up mathematics even though they study hard.



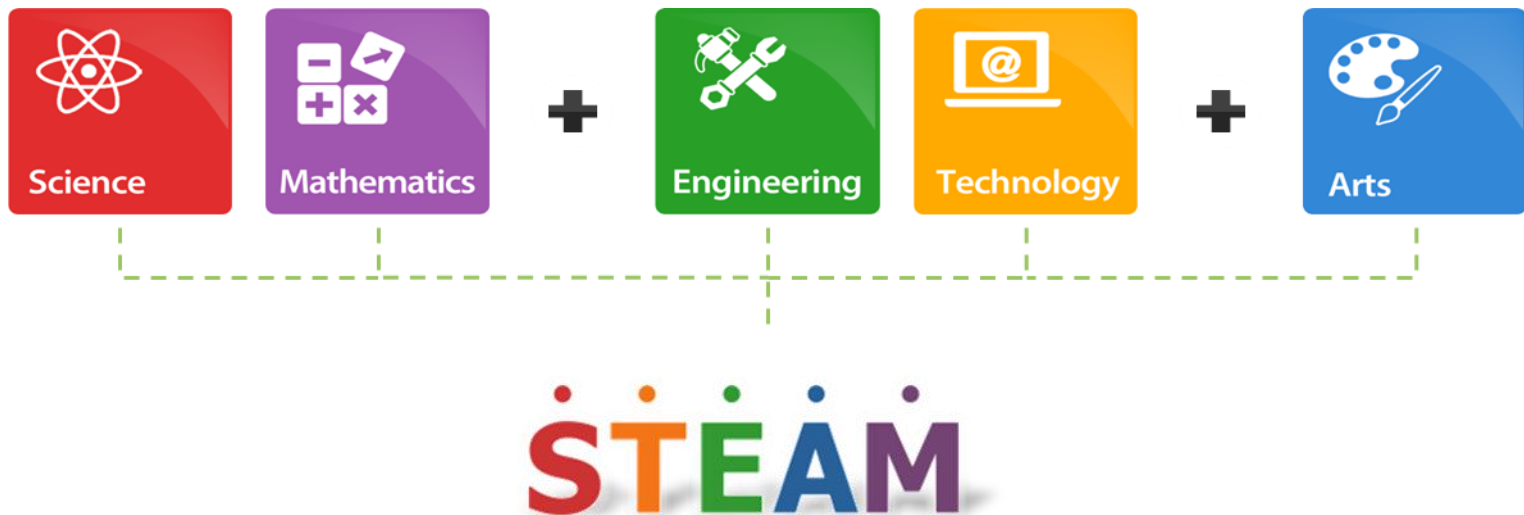
“Nurturing Creative Manpower” through Convergence

- Creativity is very important in 21st education
- I believe that creativity does not come from few “impression and meaning” in learning and **“meaning and impression”** do not come from **“compartmentalization”** between school subjects.
- STEAM is used as a methodology for “nurturing creative manpower” through Convergence!!



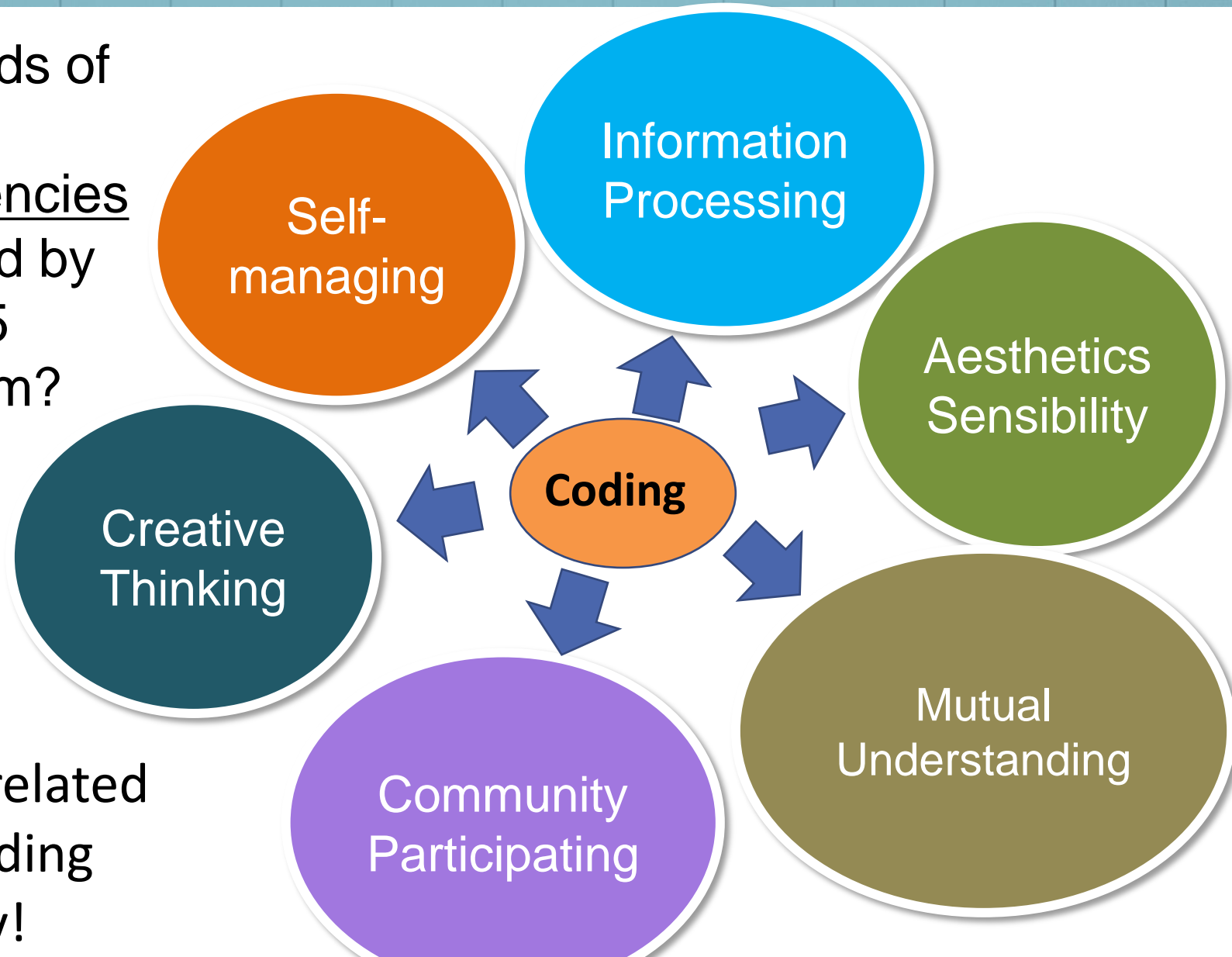
Computational Thinking in STEAM

Computational Thinking could also be a good methodology for STEAM education in the sense that all subjects of mathematics, technology, arts and science can be used for tasks of coding.



Core competencies aimed by Korean current national curriculum

What kinds of
Core Competencies
are aimed by
the 2015
curriculum?



All are related
with coding
strongly!

02



Computational Thinking Education in Korea

4 R in the Digital Era

- **R**eading, w**r**iting, A**r**ithmetic and P**r**ogramming are four basic skills for all students in the digital era.
- Does programming mean computer programming for even young kids to control a computer? Is it possible?



읽고
Reading



쓰고
w**R**iting



셈하고
a**R**ithmetic



프로그래밍하고
p**R**ogramming

Can children control machine?

- It is yes according to constructionism by Papert.
- While constructionism is based on Piaget's Constructivism, he is emphasizing the actual construction of the subject:

“Children learn best when they are actively engaged in constructing something that has personal meaning to them - be it a poem, a robot, a sandcastle or a computer program.”



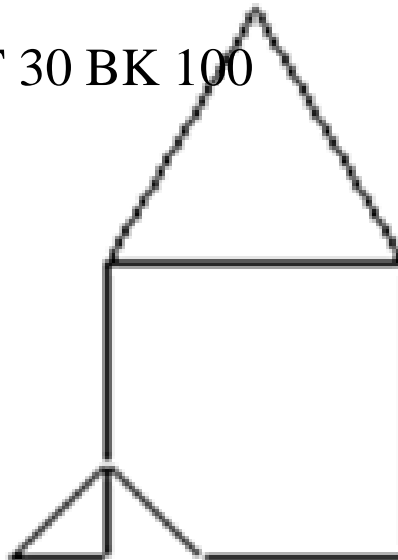
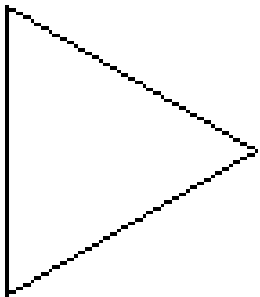
Seymour Papert (1928-2016)

SPC mode of LOGO

```
TO TRI  
  REPEAT 3 [FD 100 RT 120]  
END
```

```
TO SQUARE  
  REPEAT 4 [FD 100 RT 90]  
END
```

```
TO HOUSE  
  SQUARE FD 100 RT 30 TRI LT 30 BK 100  
END
```



Papert developed “LOGO” which is computer environment with SPC mode, not CPS

- Children can **order** computer to draw figures and **teach** words to computer **by programming activities**.

Computational Thinking under the current 2015 Curriculum



**Practical Arts
(mandatory)**

**Grades 5~6
17 hours**

From 2019



**Informatics
(mandatory)**

**Grades 7~9
34-68 hours**



**Informatics
(optional)**

**Grades 10~12
68-136 hours**




**Information science
(optional)**

From 2018



Elementary
School

Activities focused on easy playing
using block-based programming language
Entry



Junior
High

Solving problems in daily life
using block-based programming language
Entry

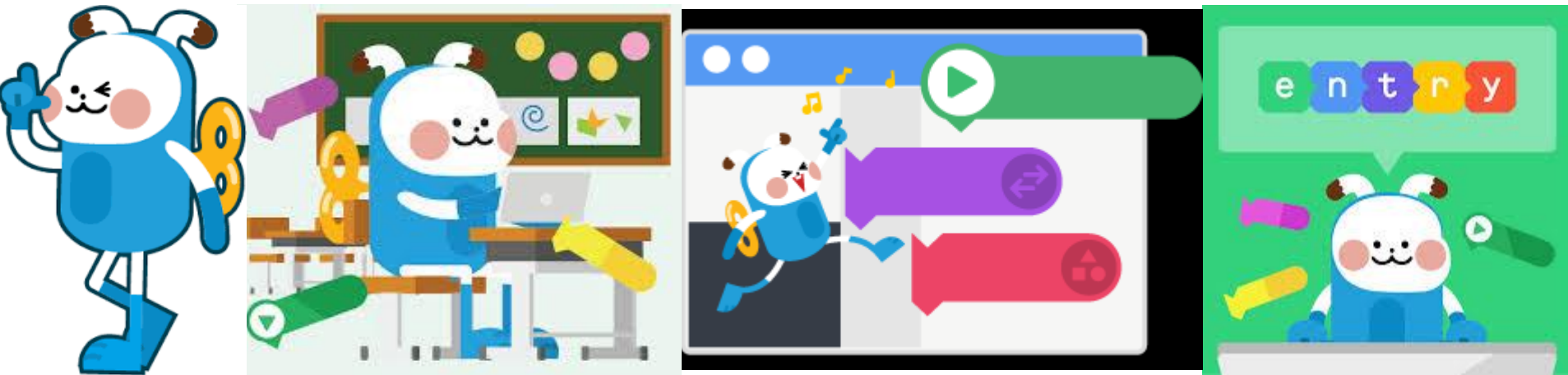


Senior
High

Advanced contents related to career path
Using text-based programming languages
Python or C++

Entry

- ENTRY is South Korea's programming language platform developed by the Entry Education Research Institute.
- It is a main block-based language used officially in Korea for elementary and junior high school students.
- It is similar to Scratch developed by Mitchel Resnick, MIT Media Lab, but much more easier.
- Visit play-entry.org to provide English version for learning, creating, and sharing.



Characteristics of Python

Python was developed in 1991 by Guido Van Rossum who is a Dutch computer programmer

- Strongly Extensible language
- Easy-to-use language
- Easy-to-understandable language
- Easy-to debug language
- Free and open source language
- Object-oriented language

Challenges

- We succeeded to introduce computational thinking education on the 2015 National curriculum
- It was very difficult to secure teaching hours on the national curriculum because it is a severe political game.
- However, it is a just beginning stage!!
- We have fatal problems for good computational thinking education
- No sufficient number of teachers
- Lack of the number of teaching hours
- No good STEAM materials for coding education

03



Some Examples of Computational Thinking Education

Example 1 with Entry

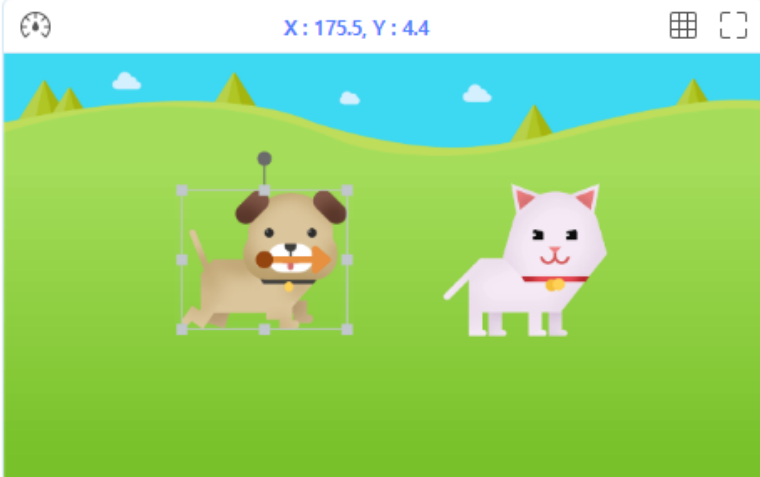
엔트리 v2.0.5

File Edit Help

엔트리 대단한 작품

장면 1 X

X: 175.5, Y: 4.4



Block Shape Sound Attribute

- Start
- Flow
- Moving
- Looks
- Brush
- Sound
- Decision
- Calculate
- Variable
- Function

When run

When key q pressed

When mouse clicked

When mouse click released

When object clicked

When object click released

When No Target message received

Send No Target message

Send No Target message and

When scene started

Start 장면 1 scene

When run

Say Hit for 2 secs Speaker

Wait 2 seconds

Say Let's go picnic for 2 secs Speaker

Wait 2 seconds

Repeat 50 times

Move 10 forward

Kitty

Puppy

X: -75.3 Y: 4.7 Size: 96.2

Rotation(°): 0.0 Direction(°): 90.0

Rotate

Puppy and Kitty

Example 2 with Entry

LED-bright-change

Example 3 with Entry

three-color-LED

Examples with Python(Spyder)

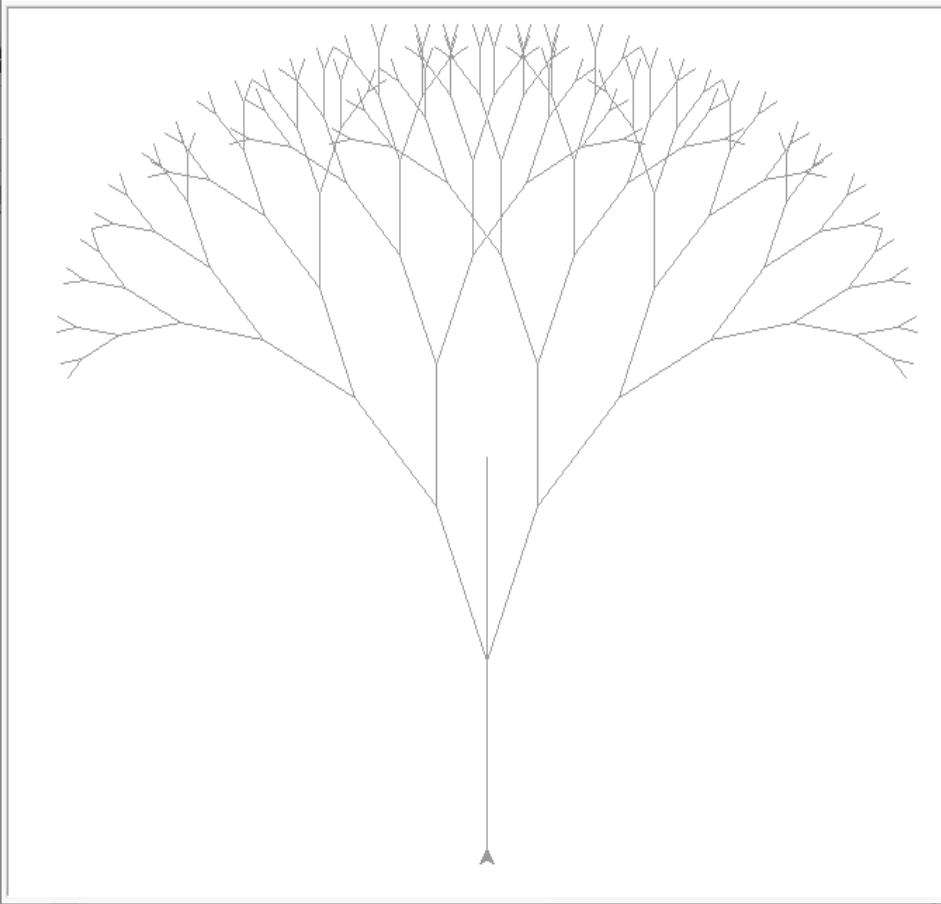
Spyder (Python 3.7)

File Edit Search Source Run Debug Consoles Projects Tools View Help

Python console

```
In [1]: from turtle import *  
In [2]: def tree(length):  
...:     if length>5:  
...:         forward (length)  
...:         right(20)  
...:         tree(length-15)  
...:         left(40)  
...:         tree(length-15)  
...:         right(20)  
...:         backward(length)  
In [3]: left(90)  
In [4]: backward(250)  
In [5]: tree(120)  
In [6]:
```

Python Turtle Graphics (응답 없음)



Permissions: RW End-of-lines: CRLF Encoding: UTF-8-GUESSED Line: 1 Column: 1 Memory: 60%

슬라이드 노트 메모 61%

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Example with Python(Spyder)

Spyder (Python 3.7)

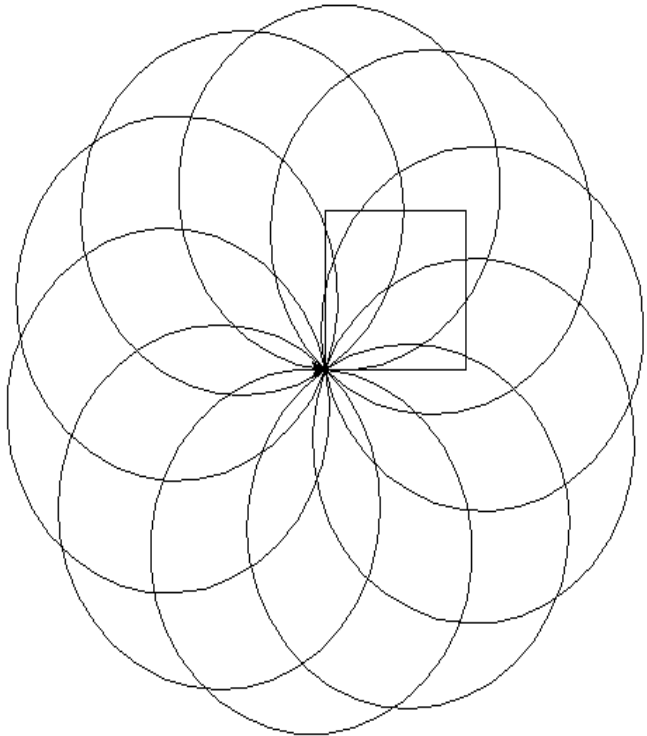
File Edit Search Source Run Debug Consoles Projects Tools View Help

Python console

```
In [1]: from turtle import *
In [2]: forward (100)
In [3]: backward (100)
In [4]: for cnt in range (4):
...:     forward (100)
...:     left (90)
...:
In [5]: def circle():
...:     for cnt in range (36):
...:         forward (20)
...:         left (10)
...:
In [6]: for i in range(10)
File "<ipython-input-6-9bf3d452bb2a>", line 1
    for i in range(10)
SyntaxError: invalid syntax

In [7]:
In [7]: for i in range(10):
...:     circle()
...:     left(36)
...:
In [8]:
```

Turtle Graphics



스슬라이드 노트 메모 61%

오전 10:37 2019-04-28

drone.mp4

[drone1113.mp4](#)

04



Conclusion

Why Coding?



Mark Zuckerberg

When I was in the sixth grade in elementary school, it was a very simple reason that I first started learning programming. I wanted to make something that I could enjoy with my sister



Bill Gates

Computer programming widens the scope of thought, makes you think better, and gives you the power to think about new solutions on all topics, regardless of the field.

Why Coding?



Barack Obama

Today, understanding of computer science has become a must. Our national competitiveness depends on how well we can teach our children this.



Steve Jobs

Everyone living in this country must learn computer programming. This is because it teaches you how to think.

Coding is important!!!

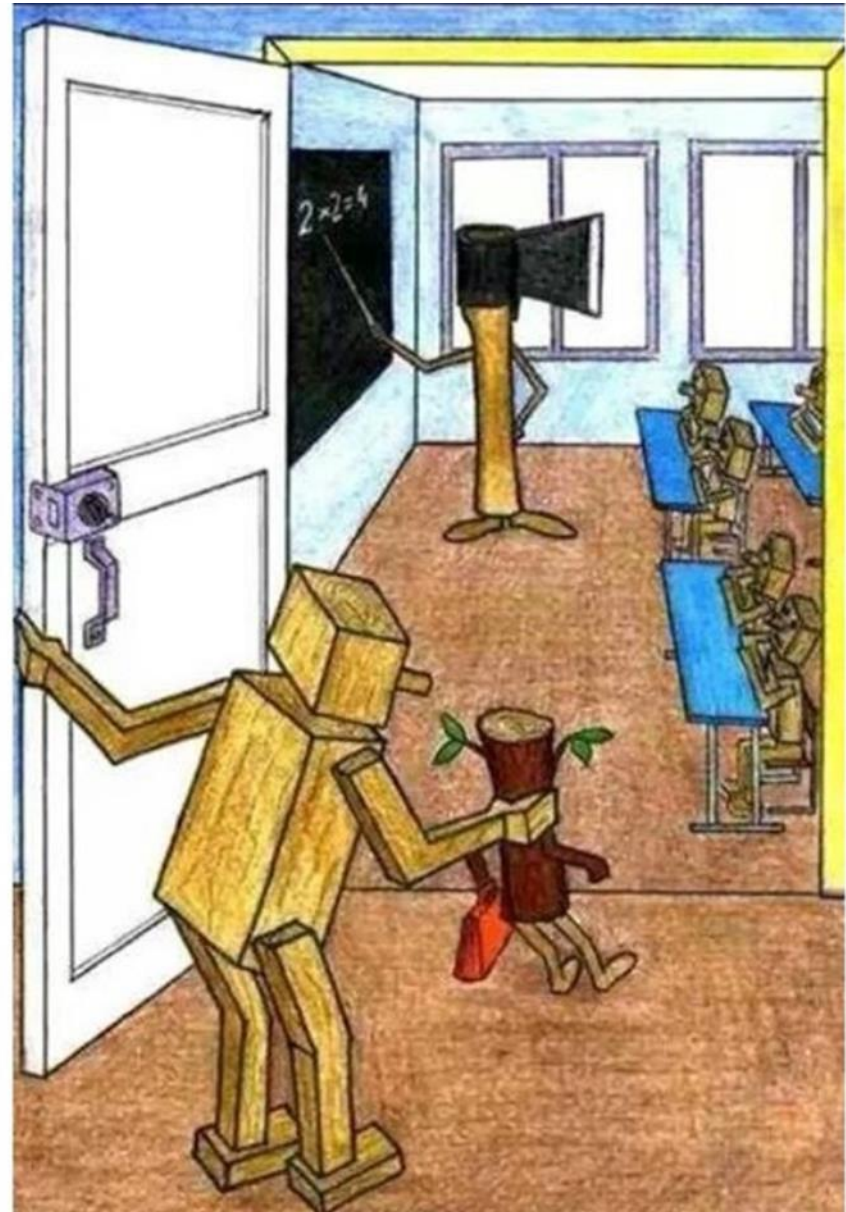
But, ...

“Problem” is on Educational Practice!

- Uniform Education
- Compartmentalization

Uniform education

- Currently, we found “uniform educational system” is still alive in most of all classrooms.
- It was driven by government in order to propel rapid economic development planned by government since 1960.
- At that time, we needed a “good worker” with basic skills in math and science for mass production during the 3rd industrial revolution.



Compartmentalization

“**Compartmentalization**” between school subjects:
Math, English, Science etc.



Educational Innovation

- In the new society, the model figure is Steve Jobs who had innovative mind on **technology** as well as **artistic design sense**.
- But, how to nurture such kind of innovative mind and artistic design sense in school?
- [Educational Innovation!!](#)
- Is it **possible** in the current school system with uniform education and compartmentalization?



Steve Jobs

1955-2011



Education **for** the Industry 4.0?

“Convergence Education”

- It is because the revolution is based on the network.
 - Network can be established by convergence!!
 - Students' converging aptitude must be trained into a habit during their **school age**!!
- But, how to make them?



Interdisciplinary Teacher Education

- We need a new approach for training teachers for computational thinking education in the 4th revolution era.
- In the compartmentalized situation we cannot train teachers with converging mind well.
- Pre-service teachers in each department do not have remaining energy for studying other subjects and other points of view besides their major subjects.

KNUE for training interdisciplinary Teachers

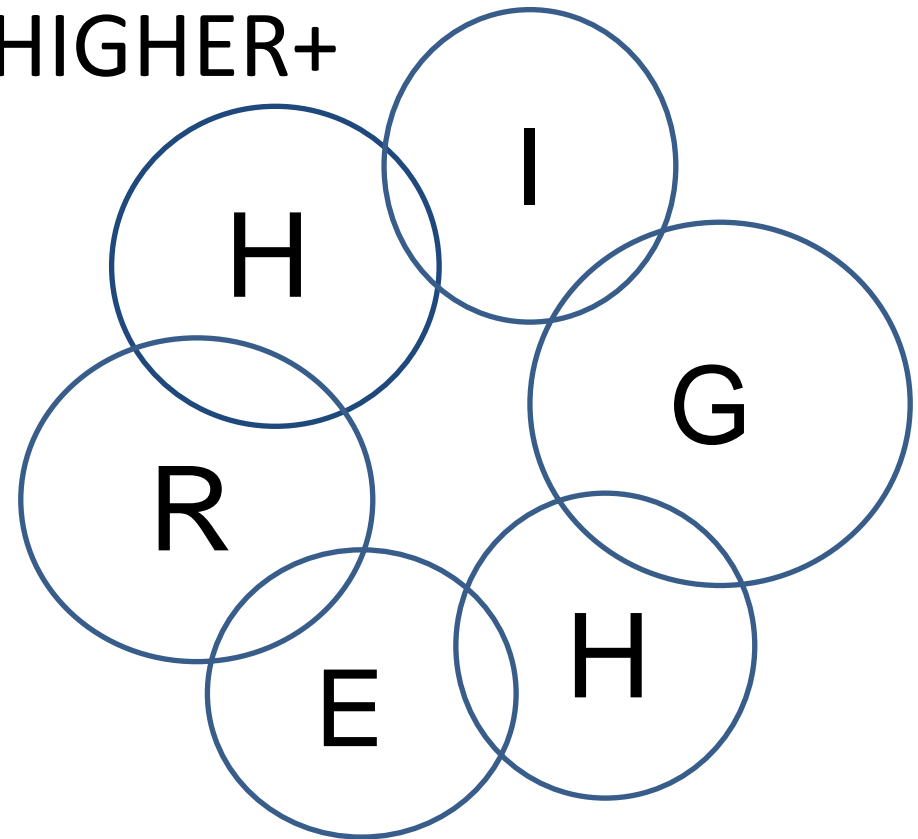
Executive Organization:

R.C. of Interdisciplinary Teacher Education

- **Goal:** To provide a new paradigm of the interdisciplinary teacher education for nurturing human resources with converging perspective required in the 4th revolution era.

- To develop Curriculum & Contents

HIGHER+



- Humanity, Integrated Intelligence, Globalization, Harmony, Experience, Renovation Mind

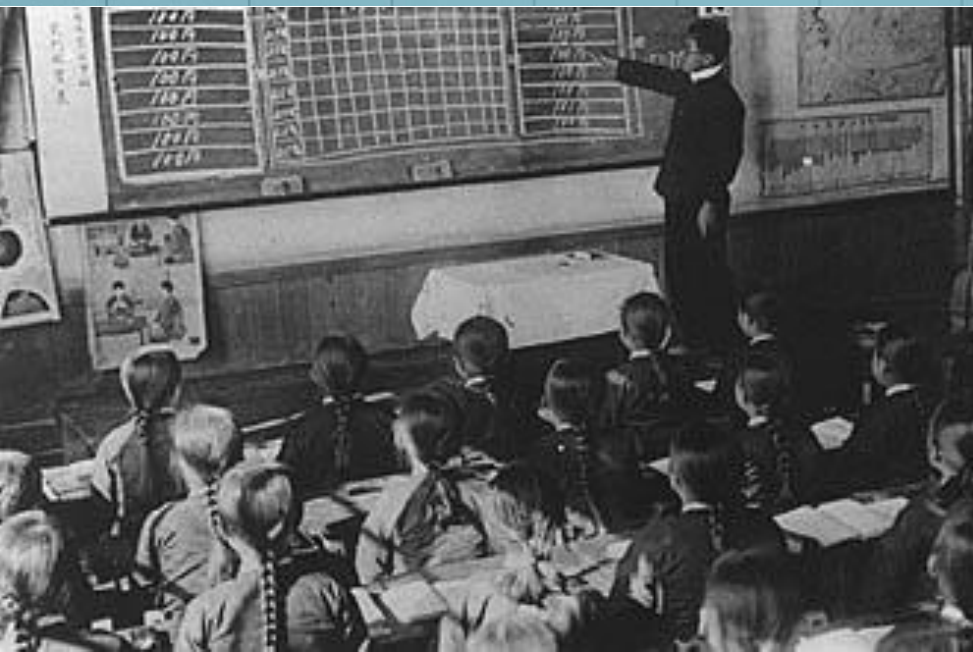
Coding Major in Graduate School

- It is a graduate program for school teachers.
- Next year, we will open it from Fall semester.
- Now we prepare the curriculum.

Additional Points for Interdisciplinary Education

- Good Facility (Maker Space)
- International Cooperation

100 years made a big difference in Classrooms?



Early 20th century Classroom



Late 20th century Classroom

Only difference is that there is a computer, a beam and a screen in the classroom. But, **what is the function of the modern facility?** It is just a supplement!

KNUE facility for interdisciplinary approach (under construction for 2022)

Facility:

A **makerspace** for **teachers** to appreciate the fourth industrial revolution and to carry out convergence education



International Cooperation for interdisciplinary approach

Collaboration with foreign countries:

- Finland LUMA center in U of Helsinki
- SEAMEO centers
- U of Chile
- VNU, University of Education
- Khon Kaen University



International Cooperation



The diagram consists of four colored circles arranged in a 2x2 grid. The top-left circle is orange and contains the text 'Joint Study and Sharing Ideas'. The top-right circle is purple and contains the text 'Sharing Teaching Materials and Aids and Case Examples'. The bottom-left circle is green and contains the text 'Instruction Model Development'. The bottom-right circle is red and contains the text 'Developing Evaluation Tools to Measure and Diagnose'.

**Joint Study
and Sharing
Ideas**

**Sharing
Teaching
Materials and
Aids and
Case
Examples**

**Instruction
Model
Development**

**Developing
Evaluation
Tools to
Measure and
Diagnose**



**Thank you for
your Attention !**