Computational Thinking:

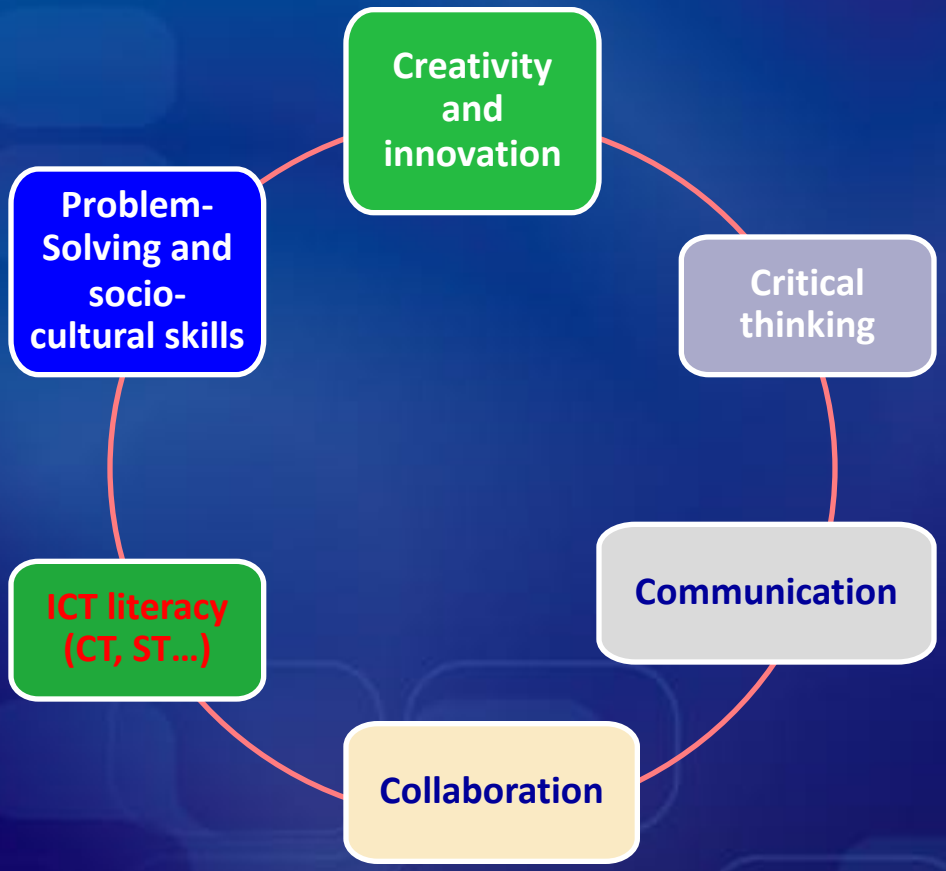
Concept and example in Vietnamese new curriculum

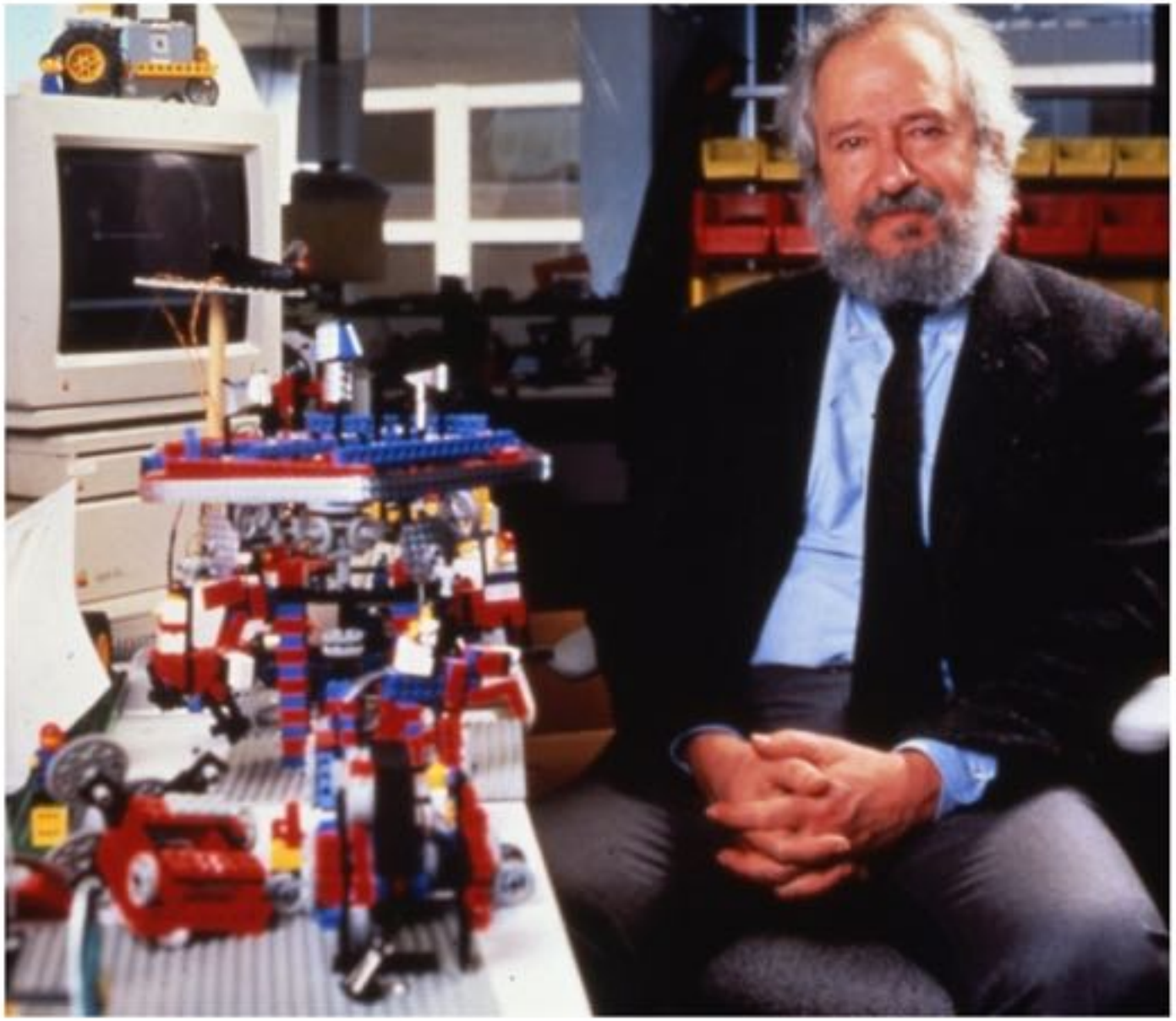
Assoc. Dr. Nguyen Chi Thanh
University of Education
Vietnam National University at Hanoi

Plan

- Introduction
- What is computational thinking (CT), Algorithmic thinking (AT); Relation with MT
- CT&AT in VN actual curriculum
- CT&AT in VN new curriculum
- Examples

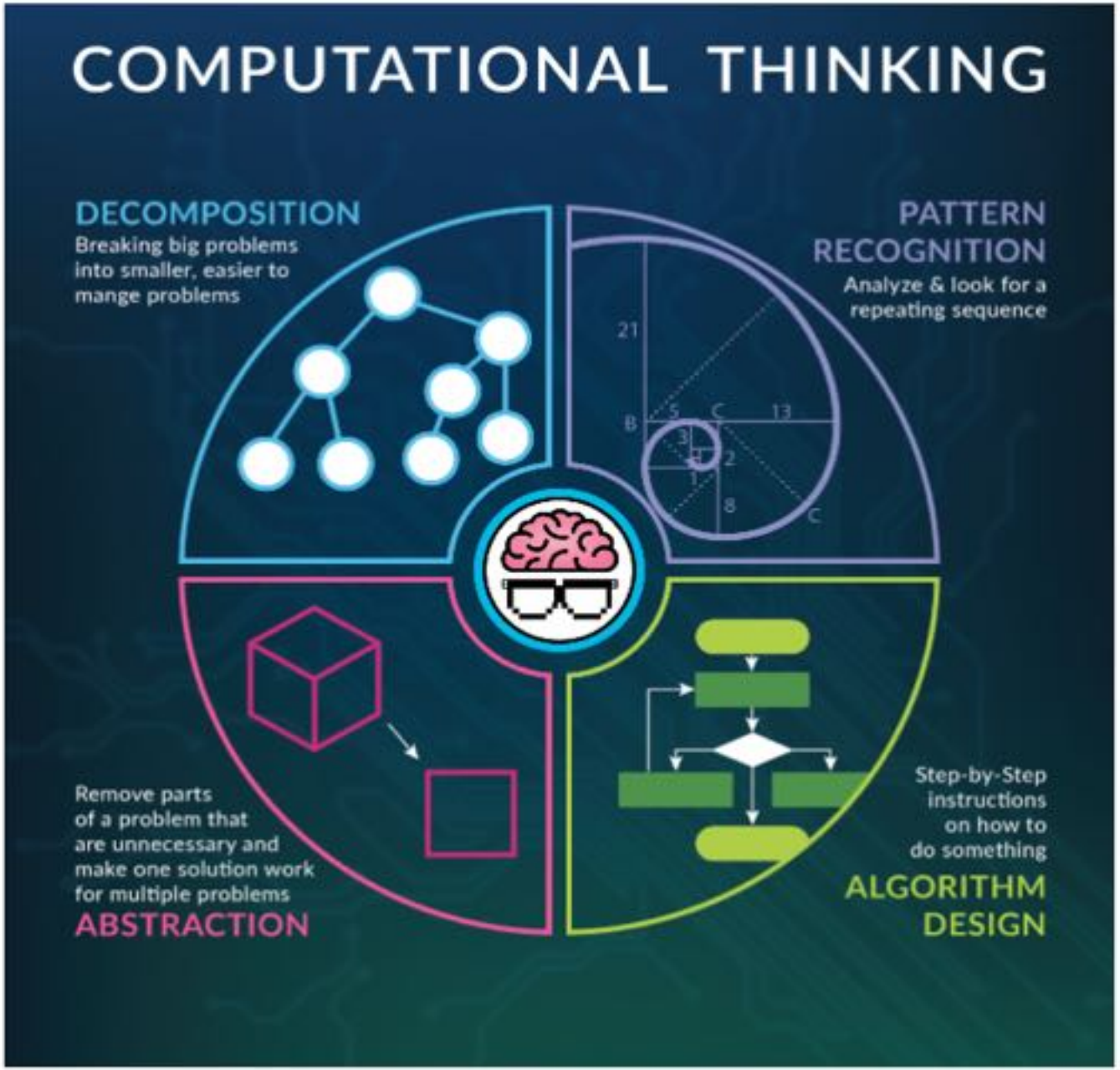
Commonly identified 21st Century Skills





Seymour Papert (29/2/1928 – 31/7/2016)
Computational thinking and LOGO language

COMPUTATIONAL THINKING

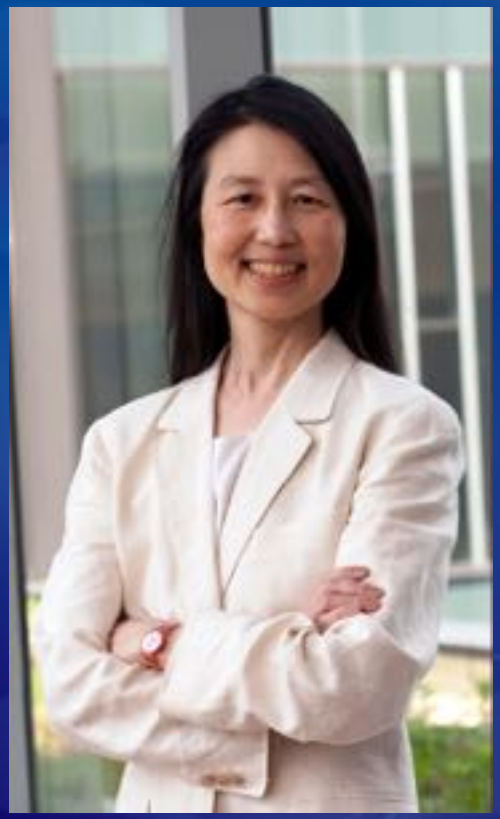


What is Computational Thinking (CT)?

CT is a ***problem-solving process*** that includes (but is not limited to) the following characteristics:

- **Formulating problems** in a way that enables us to use a computer and other tools to help solve them.
- **Logically organizing and analyzing data**
- **Representing data through abstraction** such as models and simulations
- **Automating solutions through algorithmic thinking** (a series of ordered steps)
- **Identifying, analyzing, and implementing possible solutions** with the goal of achieving the most efficient and effective combination of steps and resources
- **Generalizing and transferring this problem solving process** to a wide variety of problems

CT is



- the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent.”
- “The solutions can be carried out by a human or machine, or more generally, by combinations of humans and machines.”

Prof. Jannette M. Wing
Corporate vice president of Microsoft research

Something to consider

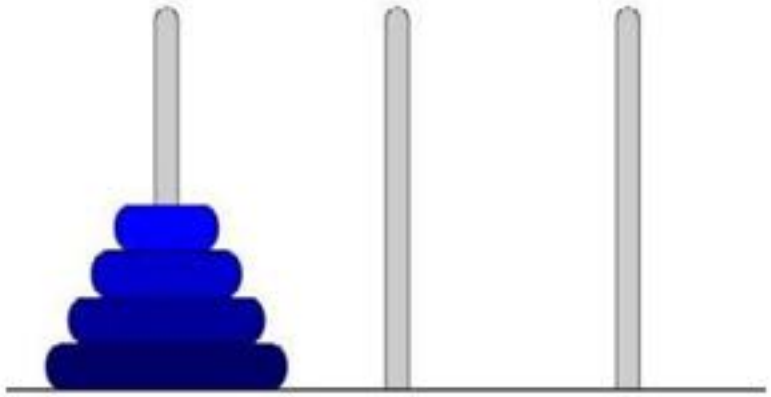
The type of thinking required by citizens for successful participation in a society is related to the raw products available and the production processes being used to solve problems.

Beyond Information Technology

- Knowing about data and ideas and using/combining these resources to solve problems.
- Move students beyond using tools and information to creating tools and information
- The raw materials require thought processes about manipulating data, using abstractions, computational thinking.

Tower of Hanoi

- Tower of Hanoi is a mathematical puzzle invented by a French Mathematician Edouard Lucas in 1883.
- The game starts by having few discs stacked in increasing order of size. The number of discs can vary, but there are only three pegs.



What is Computational Thinking?

- Asking: How difficult is the problem?
- Asking: How can it be solved?
- Asking: How can technology be applied to the problem?
- Asking: What computational strategies might be employed?
- Asking: What is the power and limit of human and computer intelligence?

Why is it important?

- It moves students beyond technology literacy
- It creates problem solvers instead of software technicians
- It emphasizes creating knowledge rather than using information
- It presents endless possibilities for creatively solving problems
- It enhances the problem-solving techniques you already teach

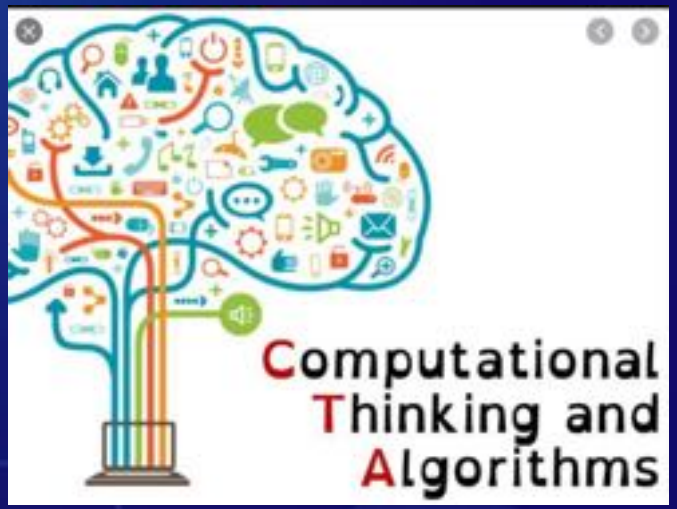
What is happening in the World?

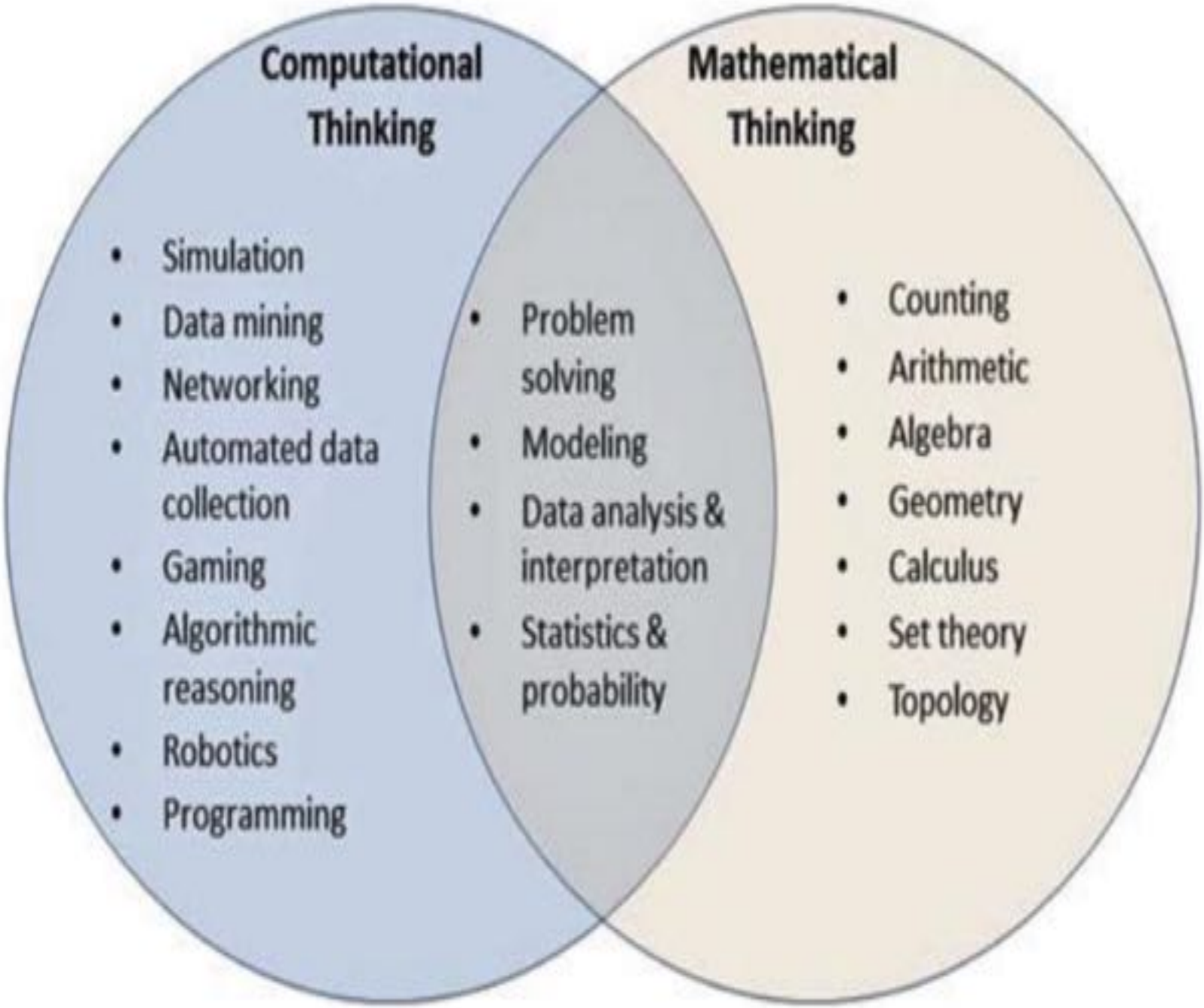
"Computational" has become part of

- Math and statistics
- Every Science
  - Biology
  - Physics
  - Chemistry
  - Nanotechnology …
- Economics
- Arts and recreation
- Engineering and design …

Algorithmic thinking

- Algorithmic thinking occurs when someone observes repeated patterns in problems and then generalizes a set of rules for dealing with such situations (so that one need not think this through anew each time that problem occurs). (Roberto, 2020)




Computational Thinking
Simulation
Data mining
Networking
Automated data collection
Gaming
Algorithmic reasoning
Robotics
Programming
Problem solving
Modeling
Data analysis & interpretation
Statistics & probability
Mathematical Thinking
Counting
Arithmetic
Algebra
Geometry
Calculus
Set theory
Topology

Computational Thinking Concepts

- Algorithm—the kingpin term
- Data—variables, data bases, Queue
- Abstraction—conceptualizing, modularizing
- Query—search, conditionals, Boolean
- Sensing & Feedback—robotics
- Iterations—loops, recursion
- Systems

Curriculum reforms in Vietnam since the 1945-the independent era up to now

1946	1946 reform: Hoang Xuan Han curriculum

- This has been influenced by French curriculum

Since 1950	1950 reform: influenced by Russian curriculum
Since 1980	1980 reform: 1 program; 3 maths textbooks
Since 2003	**2000 reform: 1 program; 1 textbooks Actual curriculum**
Since 2015	**2018 reform: 1 program; several textbooks**

Characteristics of the new curriculum

A

To develop student's competencies and values

5 core values

1) Patriotism

2) Compassion

3) Hard work

4) Honesty

5) Responsabilities

Characteristics of the new curriculum

A

To develop student's competencies and values

Competencies

10 core competencies		Special competencies for gifted students
Common competencies	**Specifics competencies**	
- Self autonomous - Collaboration and communication - Problem solving and creativities	1) Language 2) Calculation 3) Understanding on Nature and Society 4) Technology 5) Informatic 6) Esthetic 7) Health	

Introduction: 2018 education reform

- **Comprehensive and radical educational reform**
- **New curriculum**
- **Implementation Schedule**

Grade 1: 2020-2021; Grade 6: 2021-2022; Grade 10: 2022-2023 and so on

The new curriculum is expected to develop the skills of students and bring out their creative sides; to have more out-of-school and creative experience, rather than only theory.

The new curriculum will include compulsory practical activities for pupils to experience. Activities for primary schools will focus on developing their life skills, soft skills, relationships with friends, teachers and family.

Meanwhile, secondary education will focus on activities for social and community services and job-oriented activities.

Informatics: Actual curriculum

- Elementary school: non compulsory; optional from the grade 3
- Lower secondary school: non compulsory
- Upper secondary school: compulsory

Grade 10 (70 periods / year)

Grade 11 (52,5 periods / year)

Grade 12 (52,5 periods / year)

Informatics: Actual curriculum

Grade 10
Generalities + computer architecture + Office: word

Grade 11
Programing: Pascal language

Grade 12
Office: ppt, excel; Internet

In the new informatic curriculum: 12/2018

- Computer thinking: The process of identifying computational aspects in the world around us, thereby helping to solve the problem, such as knowing how to divide the problem into manageable parts and to give algorithms to solve them. Computer thinking is a basic and necessary skill for everyone, not just for computer scientists. Computer thinking is a cognitive and logical reasoning process to solve the problem, which is the ability to:

+ Decomposition of work and data

+ The generalization, identification and usage of patterns

+ Abstraction, choice of representation

+ Conditions for evaluation and estimation

+ Algorithm design

Computer thinking not only allows students to access computer topics but more importantly, it develops students' thinking skills to solve problems in learning and life.

Informatics: New curriculum

Grades 3, 4, 5: 35 periods/year

Grades 6, 7, 8, 9: 35 periods / year

Grades 10, 11, 12: 70 periods/year

Detail: Generalities, Topics, Teaching method, Assessment of the new curriculum

Informatics: New curriculum

Questions	Explaination
1. What are the changes in the curriculum objectives?	***1. General objectives of the all 3 educational levels*** - Contribute to the formation and development of all five core qualities, three general competences, and seve professional competences, in particular the informatics competence identified in the General Curriculum. - Assists in the formation and development of all students in informatics competence including **5 groups competency components:** – *Competence a: Use and management of tools, means, automation systems of IT and ICT.* – *Competence b: Knowledge and behavior in accordance with ethical, cultural and legal standards in th information society and knowledge economy.* – *Competence c: Detect and solve problems with the support of digital technology.* – *Competence d: Learning, self-learning with the support of IT and ICT systems.* – *Competence e: Communication, integration, cooperation in accordance with the era of knowledg economy.* Informatic Subject equips students with a common computer knowledge system consisting of three integrate strands: - Computer Science (CS) - Information and Communication Technology (ICT) - Digital Literacy (DL)

Informatics: New curriculum

Primary education level	LSE level	USE level
Topic C. Store, search and exchange information • Arrange to make it easy to find • Search for information in problem solving Topic F. Problem solving with the help of a computer. • Do the work according to the steps • Your tasks and computer help • Get familiar with the visual programming environment • Play and explore in an visual programming environment	Topic C. Store, search and exchange information • Social networking and some popular information exchange channels on the Internet • Characteristics of information in the digital environment • Information with problem solving • Evaluate the quality of information in problem solving Topic D. Ethics, law and culture in digital environments • Preventing some harm	Topic A. Computer and knowledge society • Introduction to Artificial Intelligence • Digital devices world • ICT Practice connecting digital devices Topic B. Computer Network and Internet • Network connections • (CS) Get familiar with computer network design Topic D. Ethics, law and culture in digital environments • Obligation of legal compliance in the digital environment • Cultural behavior and online safety

Informatics: New curriculum

	Topic D. Ethics, law and culture in digital environments • Use appropriate personal information in the digital environment • Software copyright • Information Copyright	when joining the Internet • Cultural behavior through digital media • Ethics and culture in the use of digital technology • Some legal issues about using Internet services Topic E. Applied computing • Mind map and thinking diagram software Topic F. Problem solving with the help of a computer • Visual programming Topic G. Career with Informatics • Informatics and occupations • Informatics and career orientation	• Keep humanity in the virtual world Topic E. Applied computing • (ICT) Graphic Design Software • (ICT) Photo and video editing software • (ICT) Practice creating simple website Topic F. Problem solving with the help of a computer • Create a website • (CS) Introduction to Machine Learning and Data Science • (CS) Simulation in problem solving Topic G. Career with Informatics • Introduce job categories of design and programming • Introduction job categories of data management and processing • Introduce job categories of service and management • Introduce the occupations of applied computing and the fields of information technology

So what happen in classroom?

- Computer science/technology
- Math
- Science
- Social studies
- Language arts
- Fine arts
- …

Some real examples

- Analyzing data
- Simulations
- Modeling
- Data manipulation
- Digital manipulatives & illustrators

Some examples

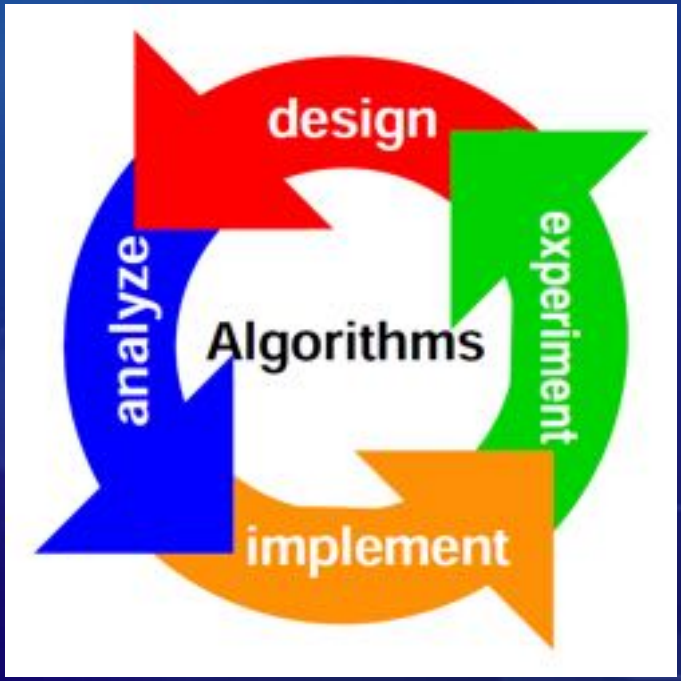
CT Concept, Capability	CS	Math	Science
Data collection	Find a data source for a problem area	Find a data source for a problem area, for example, flipping coins or throwing dice	Collect data from an experiment
Data analysis	Write a program to do basic statistical calculations on a set of data	Count occurrences of flips, dice throws and analyzing results	Analyze data from an experiment
Data representation	Use data structures such as array, linked list, stack, queue, graph, hash table, etc.	Use histogram, pie chart, bar chart to represent data; use sets, lists, graphs, etc. To contain data	Summarize data from an experiment
Problem Decomposition	Define objects and methods; define main and functions	Apply order of operations in an expression	Do a species classification
Abstraction	Use procedures to encapsulate a set of often repeated commands that perform a function; use conditionals, loops, recursion, etc.	Use variables in algebra; identify essential facts in a word problem; study functions in algebra compared to functions in programming; Use iteration to solve word problems	Build a model of a physical entity
Algorithms & procedures	Study classic algorithms; implement an algorithm for a problem area	Do long division, factoring; do carries in addition or subtraction	Do an experimental procedure
Automation		Use tools such as: geometer sketch pad; star logo; python code snippets	Use probeware
Parallelization	Threading, pipelining, dividing up data or task in such a way to be processed in parallel	Solve linear systems; do matrix multiplication	Simultaneously run experiments with different parameters
Simulation	Algorithm animation, parameter sweeping	Graph a function in a Cartesian plane and modify values of the variables	Simulate movement of the solar system

Examples in mathematics

- Geometrical constructions
- Solve quadratic equations
- Solve approximatively equations
- Calculate values of functions in specific interval with given disctance between 2 consecutive values
- …

Examples

Computational model



Examples

Computational Thinking Concept	Subject Area Application
Break a problem into parts or steps	**Literature:** Break down the analysis of a poem into analysis of meter, rhyme, imagery, structure, tone, diction, and meaning.
Recognize and find patterns or trends	**Economics:** Find cycle patterns in the rise and drop of the country's economy.
Develop instructions to solve a problem or steps for a task	**Culinary Arts:** Write a recipe for others to use.
Generalize patterns and trends into rules, principles, or insights	**Mathematics:** Figure out the rules for factoring 2nd-order polynomials
	Chemistry: Determine the rules for chemical bonding and interactions.

Thank you

Concepts useful for teaching

- Add to your own ICT knowledge.
- Help students to learn uses of ICT to represent and help solve problems within the various disciplines.
- Help students gain some underlying and/or introductory knowledge of computer science.
- Use terms associated with computing in everyday activities.
- Ask lots of ICT questions; encourage students to ask lots of questions and plan strategies to solve them.

What it's not…

- It's not just more technical details for using software
- It's not thinking like a computer
- It's not programming (necessarily)
- It doesn't always require a computer
- It's not yet one more thing to add to your curriculum

How is it different from other learning strategies?

- Not just procedural
- Not just constructionist
- Not just integrated

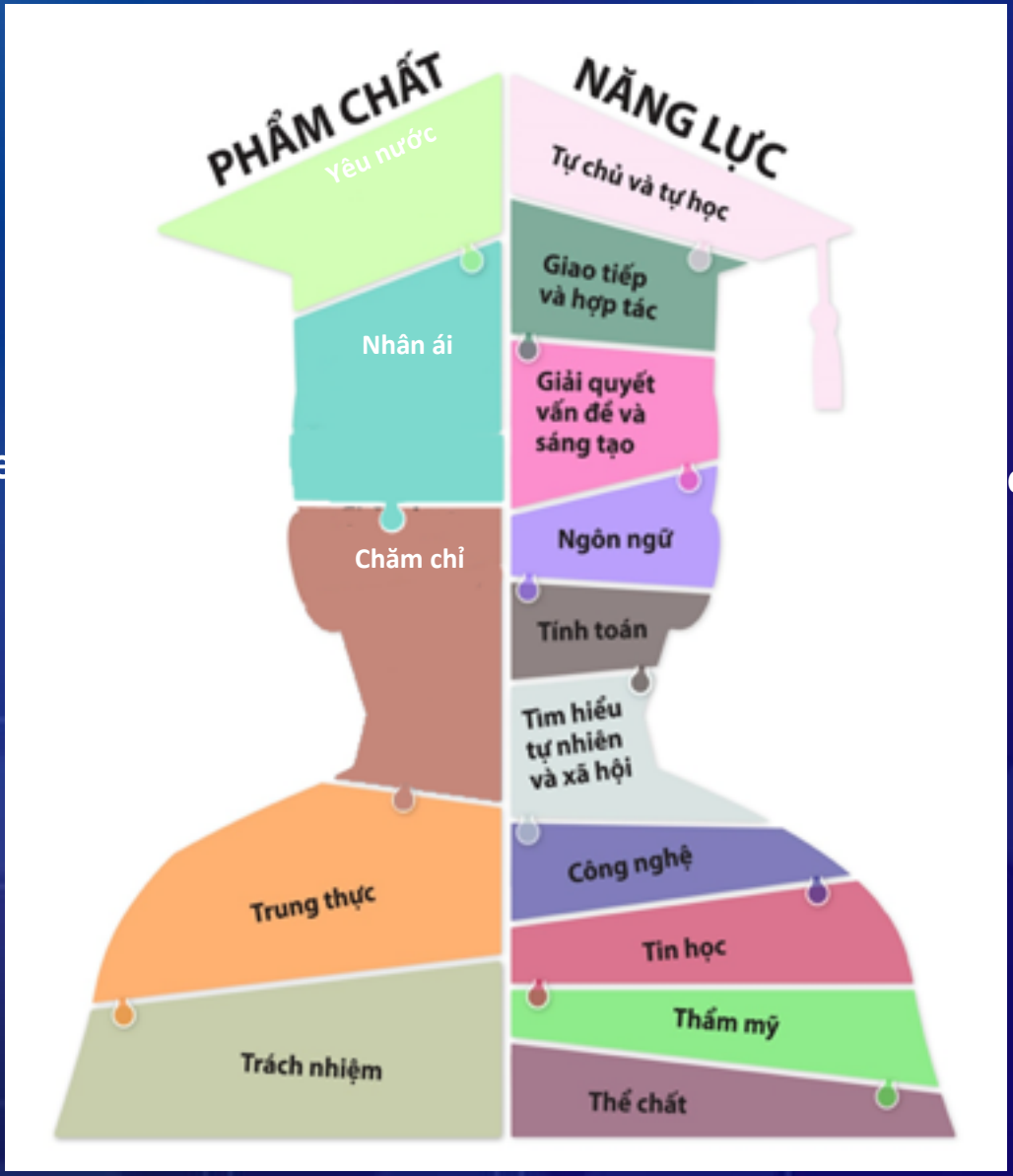
I. Characteristics of the new curriculum

To develop student's competencies and values

Student portrait

5 core

etencies



I. Characteristics of the new curriculum

B

Teaching subjects

Basic education

Primary education

Teaching subject	1) Vietnamese 5) Nature and society (Grades 1, 2, 3) 2) Maths 6) History and Geography (Grades 4, 5) 3) Moral edu. 7) Sciences (Grades 4, 5) 4) Art edu. 8) Foreign languages 1 (Grades 3, 4, 5) 9) Informatic and Technology (Grades 3, 4, 5)
	10) Physical education 11) Experienced activities
Optional subjects	Ethnic languages, Foreign languages 1 (Grades 1, 2)

I. Characteristics of the new curriculum

B

Teaching subjects

Feb-20

Basic education	Lower secondary edu.
Teaching subjects	1) Literature 2) Mathematics 3) Language 1 4) Civic education 5) Sciences 6) History and Geography 7) Art education
	8) Informatic 9) Technology 10) Physical education 11) Experienced activities, Career orientation 12) Local education
Optional	Ethnic language, Language 2

II. Characteristics of the new curriculum

B

Teaching subjects

Career oriented education – upper secondary education

Group of teaching subjects	Teaching subjects
Compulsory	Literature, Maths , Language 1, Physical education, Military education, Experienced activities, Local education
Elective subjects	*To select 5 subjects, at least 1 by group*
Humanities	Geography, History, Civic education
Sciences and Technology	Physic, Chemistry, Biology
Technology and Art	Technology, Informatic, Art
Optional	Ethnic group, Language 2

An example of curriculum analysis of 2000: Informatic within maths curriculum

France	Vietnam
Variable informatic: very few exercices	
To write an algorithm: Very few exercices	To write an algorithm: More algorithm but only about on iterative algorithm
Bréal 0	M3 0
« To execute » a program: More exercices	« To execute » a program: Few exercices
Bréal 0	M3 5

- There are algorithm but no teaching algorithm
- There are program but no teaching programing