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Academic Paper

Guidelines for Organizing Computer Science Courses at the Elementary Level

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Abstract

Technology Learning, known as Mathematical Science, aims to provide students with learning and computing thinking skills. Analytical thinking for problem solving is a step-by-step and systematic application of computer science knowledge. Information and communication technology to solve problems are found in real life. Learning management and clear assessment will help all teachers—particularly those in science and computer--plan to manage teaching and learning effectively. In this paper, the author analyzed contents for a computer science course at the elementary level and divided them by four indicators in four parts: Part 1, Indicators related to *Problem Solving*. In the grades 1-3, students will be able to study simple problem solving. The use of various games allows students to practice problem solving skills by getting prepared before facing the real situation. Part 2 *Programming Metrics* is to take the problem-solving skills from Part 1 and put them in an algorithm. In the beginning it may be programming and using simple command cards; ready-made programs may be subsequently used to write introductory commands. Part 3 Indicators on the use of *Software Programs*, such as word processors (like MS Word) and data presentation programs (PowerPoint) which students use in various instructional settings; and Part 4 Indicators on using *Safe Information Technology*. The study provides guidelines for use and maintenance of the equipment, proper use of information technology in daily life, and understanding of students' rights, duties, and respect for others.

Keywords: *Curriculum, computing science, elementary, content classification, content indicators*

1. Introduction

The guidelines for Thai basic education management are required in accordance with the changes of economic world, society, culture, environment, and scientific and technological knowledge that is growing rapidly to develop and enhance the capacity of people and the country's competitiveness. Upgrading the quality of education and learning to the international standards are the goals of Thailand 4.0 and required skills in the 21st century. These are for students to maximize their potential to compete and live creatively in the global community.

The management of education for the development of quality people is to ensure that students develop their full potential and know how to think critically, solve problems creatively, and learn on their own to live in society happily (Jit-arun, 2007). The reform of the learning process to develop learners has been developed continuously and with quality agencies involved in the reform of the learning process at all levels must have a strong management in various operations that drive the learning reform in the organizational structure, corporate mission and behavior of personnel in the organization (Kerkhao, 2003)

The Ministry of Education Thailand (2017) has announced the improvement of learning indicators and content. The core learning subject group of Science is clearly prescribed according to the Core Curriculum of Basic Education BE 2551, by specifying the basic course of science and technology as computer science course. Teachers of science and computer subjects need to update their knowledge and skills to be able to organize the content, manage learning and handle assessment appropriately.

The course of computer science encompasses technology adoption and concepts in computational science and computer science applied in daily life as a basis to think, analyze and solve problems systematically and creatively, as well as to be able to create innovations that help improve the quality of life for a good future. Teachers need to provide learner-based instruction as a key method to create and develop learners with varied characteristics. Teaching and learning management focus on learners and encourage them to explore, discover and learn on their own. The subjects must be in line with students' individual abilities and needs under good guidance for educational management. Educational philosophy and learning theories help teachers identify eclectic approaches to suit learners' characteristics and learning styles effectively (Yuedtuk, 1999). Teaching with an emphasis on learners takes all learning aspects into consideration both physically, emotionally, socially, intellectually, in terms of knowledge, skills, and attitudes. Both intelligence and emotion will be developed in learners to be smart, good, and happy (Chaithieng, 2007).

In this paper, the author reports the guidelines for organizing computer science courses at the elementary level in Thai Basic Education.

2. Course Goals

The Institute for the Promotion of Teaching Science and Technology Thailand (2018) has set important goals for the development of learners in teaching and learning in computational science as follows:

(1) To use computational thinking skills in analytical and systematic thinking and problem solving.

(2) To acquire skills in searching for information, assessing, organizing, analyzing, synthesizing and applying information to solve problems.

(3) To apply knowledge in computer science, digital media, information and communication technology in solving real life problems in creative collaboration for the benefit of oneself and society.

(4) To use information technology and communication in a safe, knowledgeable, responsible and ethical manner.

The above goals are to help teachers to divide content and manage learning and assessment appropriately.

3. Content Classification

The example of content division in elementary school courses is given in detail by Ministry of Education (2017) with indicators in 4 parts as follows:

Part 1 *Indicators related to Problem Solving* in grades 1-3: students will be able to study and use simple problem-solving skills. The use of various games allows students to practice problem solving skills when faced with difficult situations.

Part 2 *Programming Metrics* takes the problem-solving concepts from Part 1 and creates them in the form of an algorithm. In the beginning, it may be programming using simple command cards. Later, there may be a program that can be used to write basic commands.

Part 3: *Indicators about the Use of Software Programs*, such as word processors (e.g., MS Word) and data presentation programs (MS PowerPoint), which help students to know how to use various commands well.

Part 4 *Indicators on the Use of Safe Information Technology* serve as the guidelines for use and maintenance of the equipment, proper use of information technology in daily life, understanding of users' rights and duties, and respect for the rights of others.

The content classification according to the four indicators above is shown in Tables 1-4.

Table 1: Part 1 Indicators Related to Problem Solving

Class	Indicators	Core learning content
Grade 1	1. Solve simple problems using trial and error, comparison. 2. Show a sequence of steps or simple solutions using images, symbols or text.	- Solving problems successfully can be done using troubleshooting steps. - Simple problems, such as maze games, spot the differences games. bag packing. - Show troubleshooting steps. This can be done by writing, telling, drawing, or using symbols. - Simple problems, such as maze games, spot the differences games, bag packing.
Grade 2	1. Show a sequence of steps or simple solutions using images, symbols or text.	- Show troubleshooting steps. This can be done by writing, telling, drawing, or using symbols. - Simple problems, such as 6-12 puzzles, dressing up for school.
Grade 3	1. Demonstrate a simple working algorithm or problem-solving using images, symbols, or text.	- Algorithms are steps used to solve problems. - Algorithm display. This can be done by writing, telling, drawing, or using symbols. - Examples of problems are Monopoly game, Snake and Ladder game, Tetris game, OX game, walking to the cafeteria, cleaning the classroom.
Grade 4	1. Use logical reasoning to solve problems. Working description and forecasting results from a simple problem.	- Logical reasoning is the use of all-encompassing rules or conditions to be considered in solving problems. Working description or forecasting the outcome - Different starting states will produce different results. - Examples of problems, such as OX games, calculated programs. Programs that have multiple characters and have different commands or communication with each other, school trip by various methods.

Class	Indicators	Core learning content
Grade 5	1. Use logical reasoning to solve problems. Working description forecasting results from a simple problem.	- Logical reasoning is the introduction of rules or conditions that cover all cases to be considered in solving the problem working description or forecasting the outcome. - Different starting states will produce different results. - Examples of problems, such as Sudoku, a number prediction program. Program to generate geometry based on input values. Organizing the Holiday. Homework place in the kitchen.
Grade 6	1. Use logical reasoning to explain and design solutions to problems encountered in everyday life.	• Step-by-step solutions will help you solve problems effectively. • Logical reasoning is the introduction of rules or conditions that cover all cases to be considered in solving the problem. • The concept of repetitive work and conditions. • Considering an iterative or conditional workflow is a method to help design an efficient solution. • Examples of problems, such as finding the desired page number as quickly as possible, guessing the number 1-1 million by answering correctly within 20 questions, calculating travel time. taking into account distance, time break point.

Table 2: Part 2 Programming Metrics

Class	Indicators	Core learning content
Grade 1	1. Write a simple program. by using software or media.	- Programming is the creation of a sequence of instructions for the computer to run. - Example programs, such as writing a program to order the characters to move, shrink, enlarge, change the shape. - Programming software or media, such as using instruction cards to show programming, Code.org.
Grade 2	1. Write a simple program by using software or media and check for program errors.	- Example program, for example, write a program to order the characters to work as they want and check for errors Modified to achieve the desired results. - Error detection. This can be done by checking the commands that report errors. Or if the results are not as you want, check each command one by one. - Programming software or media, such as using instruction cards to show programming, Code.org.
Grade 3	1. Write a simple program by using software or media and check for program errors.	- Programming is the creation of a sequence of instructions for the computer to run. - Example programs, for example, write a program that instructs the characters to repeat infinitely. - Error detection. This can be done by checking the commands that report errors. Or if the results are not as you want, check each command one by one. - Programming software or media, such as using instruction cards to show programming, Code.org.

Class	Indicators	Core learning content
Grade 4	1. Simple design and programming by using software or media and check for errors and fix them.	- Simple program design, such as storyboard design or algorithm design. - Programming is the creation of a sequence of instructions for the computer to run to achieve the desired results. If there is an error, check the operation one by one. When it finds the point where the result is invalid, keep editing until the correct result is obtained. - Examples of programs with stories, such as interactive stories, short cartoons, daily routines. animation. - Practice detecting errors from other people's programs. It will help develop the skills to find the cause of the problem better. - Programming software, such as Scratch, and logo.
Grade 5	1. Design and write programs with simple logical reasoning. Check for errors and fix them.	- Program design can be done by writing in text or flowcharts. - Designing and writing a program with comprehensive validation of all conditions in order to achieve the correct results that meet the requirements. - If there is an error, check the operation one by one. When it finds a point that makes the result incorrect, correct it until the correct result is obtained. - Practice detecting errors from other people's programs. It will help develop the skills to find the cause of the problem better. - Example programs, such as programs to check even numbers, odd numbers, programs to get weight or height information and show the proportions of the body. The program instructs the character to fulfill the specified conditions. - Programming software such as Scratch, and logo
Grade 6	1. Simple design and programming to solve everyday problems. Check for program errors and fix them.	- Program design can be done by writing in text or flowcharts. - Design and write programs that use variables, iterations, condition checks. - If there is an error, check the operation one by one. When it finds a point that makes the result incorrect, correct it until the correct result is obtained. - Practice detecting errors from other people's programs to improve your root cause skills. - Example programs, such as game programs, GCSE valuation programs, and typing practice games. - Programming software, such as Scratch, and logo

Table 3: Part 3 Indicators about the Use of Software Packages

Class	Indicators	Core learning content
Grade 1	1. Use technology to create, store and retrieve information for the intended purpose.	- Basic software operations, such as entering and exiting programs, creating files, storing files, retrieving files. This can be done in programs, such as word processors and graphics program presentation program

Class	Indicators	Core learning content
		- Systematic creation and storage of files allows them to run. Find information easily and quickly.
Grade 2	1. Use technology to create, categorize, search, store, and retrieve information for the purpose.	- Basic software operations, such as entering and exiting programs, creating files, storing files, and retrieving files. document editing. This can be done in programs, such as word processors, graphics program and presentation program. - Creating, copying, moving, deleting, renaming, categorizing files and the folder systematically will make it run. Find information easily and quickly.
Grade 3	1. Use the Internet to search for knowledge.	- The Internet is a large network that makes communication easier and faster and is a source of knowledge that helps in learning and life. - A web browser is a program for reading documents on web pages.
		- Internet browsing. This can be done using a search site. And must define the appropriate search terms to get the information as needed. - Knowledge information, such as cooking methods, origami methods, information on Thai history. (It could be knowledge of other subjects or subjects of interest at that time.) - Safe use of the Internet should be under the supervision of teachers or parents.
	2. Collect, process and present information using the software for the intended purpose.	- Data collection. This can be done by specifying the desired topic. Prepare a recording device. - Simple processing, such as compare, group, and sort. - Information can be presented in many ways as appropriate, such as telling, documenting, reporting and making notice board - Use of the software works for its intended purpose, such as using presentation software. or graphics software. Create an image chart. Use word processing software to make announcements or white papers. Use table software to process data.
Grade 4	1. Use the Internet to search for knowledge and assess the reliability of the information.	- Using keywords that are relevant, concise, will result in fast and relevant results. - Assessing the credibility of the information, such as considering the type of website. (Government agency, news agency, organization). Author Date published reference information. - When getting the information you need from different websites, the content must be considered, compared, and then selected information that is consistent and relevant. - In making reports or presenting information, the information must be compiled, summarized, in its own language that is appropriate for the target audience and the method of presentation. (Integrated with Thai language course.)

Class	Indicators	Core learning content
	2. Collect, evaluate and present data and information, using a variety of software to solve everyday problems.	- Data collection This can be done by specifying the desired topic. Prepare a recording device. - Simple processing, such as compare, group, sort, and sum. - Analyze the results and make possible alternatives. Evaluate options (compare, judge) . - Information can be presented in a variety of ways as appropriate, such as tell-tales, whitepapers, posters, presentation programs. - Using the software to solve everyday problems, such as exploring the lunch menu using questionnaires and collecting data. Use spreadsheet software to process the data. Gather information about nutritional values and create a 5-day meal plan. Use the software to present alternative food item survey results and nutrition information.
Class	**Indicators**	**Core learning content**
Grade 5	1. Use the Internet to search for information. Communicate and work together. Assess the reliability of the information.	- Internet search and consideration of search results - Internet communication, such as e-mails, blogs, chat programs. - letter writing (Integrated with Thai language course) . - Using the Internet for communication and collaboration, such as for scheduling in group meetings. public relations activities in the classroom knowledge exchange study opinion under the supervision of a teacher. - Assessing the reliability of the data, e.g., data integrity from multiple sources: Author, date of publication of information. - Good information must contain all details, such as advantages and disadvantages, and benefit and harm.
	2. Collect, evaluate, and present objective data and information using a variety of software or Internet-based services to solve everyday problems.	- Gathering, processing, making choices, and evaluating results will provide information for effective problem solving or decision-making. - Using a variety of software or Internet-based services to collect, process, choose, evaluate, present, provide solutions to problems quickly, accurately, and accurately. - Examples of problems, such as photographing and exploring local maps to suggest ways to manage empty spaces. Take an online poll and analyze data, present data by using blog or web page
Grade 6	1. Simple design and programming to solve everyday problems Check for program errors and fix them.	- Program design can be done by writing in text or flowcharts. - Design and write programs that use variables, iterations, and condition checks. - If there is an error, check the operation one by one. When it finds the point where the result is invalid, keep editing until the correct result is obtained.

Class	Indicators	Core learning content
		- Practice detecting errors from other people's programs to improve your root cause skills. - Examples of programs, such as game programs, GCSE valuation programs, and typing practice games. - Programming software, such as Scratch, and logo.
	2. Use the Internet to search effectively.	- Efficient search. It's the quickest way to find the right information from multiple reliable sources and the data is consistent. - Using advanced search techniques, such as operators. Specifying data formats or file types. - Ranking of search engine results. - Compilation Summary (Integrated with Thai language course).

Table 4: Part 4 Indicators on the Use of Safe Information Technology

Class	Indicators	Core learning content
Grade 1	1. Use information technology safely. Comply with the computer sharing agreement. Basic equipment maintenance use properly.	- Safe use of information technology, such as knowing personal information. The dangers of disseminating personal information and do not share personal information with anyone except parents or teachers. Notify stakeholders when they need help with usage.
		- Guidelines for use and maintenance of the device, such as not writing on the device, cleaning, using the device properly. - Proper use, such as correct sitting position. Resting your eyes when using the device for a long time Be careful of accidents in use.
Grade 2	1. Use information technology safely. Comply with the computer sharing agreement. Basic equipment maintenance use properly.	- Safe use of information technology, such as knowing personal information. The dangers of disseminating personal information and do not share personal information with anyone except parents or teachers. Notify stakeholders when they need help with usage. - Guidelines for use and maintenance of the device, such as not writing on the device, cleaning, using the device properly. - Proper use, such as correct sitting position. Resting your eyes when using the device for a long time Be careful of accidents in use.
Grade 3	1. Use information technology safely. Comply with the terms of use of the Internet.	- Safe use of information technology, such as protecting personal information. - Seek help from teachers or parents. When there is a problem in use. When you find information or people that make you uncomfortable. - Compliance with the terms of the use of the Internet will cause no harm to oneself and others, such as not using profanity, ridicule, insulting, causing damage or regret to others. - Advantages and disadvantages of using information and communication technology.

Class	Indicators	Core learning content
Grade 4	1. Use information technology safely understand their rights and duties respect for the rights of others. Notify relevant parties when inappropriate information or persons are found.	- Safe use of information technology, understand their rights and duties. Respect the rights of others, such as not making false statements and sending them to others. Don't cause trouble to others by sending spam. chain message. Forward posts with other people's personal information. send game invitation. Do not access other people's personal information or homework without permission. Do not use someone else's computer/account name. - Communicating with manners and knowing the time. - Protection of personal data, such as logging out of the system at termination. Don't tell your password. Does not give identification number.
Grade 5	1. Use information technology safely, be polite, understand their rights and duties. Respect for the rights of others. Notify relevant parties when inappropriate information or persons are found.	- The dangers of use and cybercrime. - Internet communication etiquette. (Integrated with related subjects)
Grade 6	1. Use information technology to work together safely. Understand their rights and duties. Respect for the rights of others. Notify relevant parties when inappropriate information or persons are found.	- The dangers of use and cybercrime. Prevention guidelines: - How to set a password? - Assigning licenses (Access rights) . - Malware detection and prevention guidelines. - The danger of installing software on the Internet.

It should be noted that there is also integration between content, such as Programming (Part 2) and Problem-Solving Design (Part 1) or Using Software Proposing a Solution (Part 3) and Programming (Parts 1 and 2).

4. Analysis

4.1 Teacher's Role

From the new curriculum of Thai Basic Education, technology learning has been added to the science subject group. Some educational institutions are confused about the content distribution. For science and computer teachers regarding the management of teaching personnel, the prescribed curriculum is also a model in which teachers and graduates of teaching science should follow in their majors and rely on the indicators in various subject areas on teaching duties. The teacher’s roles can correspond with four indicators: responsibility for laying the groundwork in Part 1 on problem solving skills, the adoption of programming languages and software applications including the use of safe information technology in Parts 2-4.

4.2 Learning Management

The content in Part 1 is about solving problems; students will practice observing situations in daily life including the situation in question for practice in analyzing to solve a simple problem by trial-and-error comparison to logical reasoning in solving a particular problem. A sequence of steps for solving problems, such as using pictograms or software to describe the sequence of such steps. Teachers can use problem-based learning management (PBL) or a 5-step problem-solving process (5Es).

The content in Part 2 on programming is meant for the teacher to manage teaching in the course that has the learner in focus to create a sequence of instructions. (programming), and use simple classroom materials, such as instruction cards show programming design, using Storyboard or Algorithm design. Another form is the use of software packages to help with programming, such as Scratch and logo, as well as students' practice in programming through websites, particularly Code.org.

The content in Part 3 familiarizes learners with the use of various software programs in collecting, evaluating, and presenting information to solve everyday problems. Through websites and various graduate programs, educational institutions are to provide resources that facilitate learning, such as computers, Internet signal system and related programs, both computer programs and applications via tablets or mobile phones. Teachers are to organize learning to give students the opportunity to practice computer and problem-solving skills through demonstrations or self-study in preferably the flipped classroom.

The content in Section 4 on using Safe Information Technology emphasizes the rights and duties of oneself and others. Teachers may use a learning management model, such as a case study or simulation to provide students with the opportunity to discuss, brainstorm, and collaborate in pair work and cooperative learning activities.

4.3 Evaluation

As for learning performance assessments, teachers may include authentic assessments, practical skills exercises and classroom participation in problem-solving design as in Section 3. Assessment should be based on performance on programming as in Section 2, reporting on searched information as in Section 4, or project development on problem solving design and presentation which integrates the contents of Parts 1-4.

4.4 Final Point

Content classification according to the use of metrics as shown in this paper is to ensure consistency in the division of roles and duties of teachers together with learning management and evaluation. The use of metrics as such definitely allows teachers to design learning management clearly and effectively.

5. The Author

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