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Improving Computational Thinking and Teamwork by Applying Balanced Scorecard for Sustainable Development

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Abstract: This work aimed to analyze the concept of a balance scorecard (BSC) tool integrated with computational thinking (CT) in university education. An experiential approach to learning about the CT through the study of a BSC performance evaluation tool has been reported. The BSC project offers students hands-on experience with the team-based, cross-functional, and strategic aspects of conceptual thinking. This study integrates the four aspects of the BSC into CT to evaluate students through four perspectives. The experiential approach requires each student to compose a team, find information about their motivation, and develop BSC concepts that apply learning performance in a computational thinking course. The conclusion suggests that the BSC project had a positive impact on the students who participated, indicating their overall knowledge and understanding of functional areas and relationships within the teamwork cooperation were enhanced. Our paper reports an experiential method of learning CT by studying BSC performance evaluation tools. The application example can enhance students' logical thinking, what is indispensable and essential in maintaining competitiveness.

Keywords: computational thinking; balanced scorecard; problem-solving; sustainability

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1. Introduction

Computational thinking (CT) is a term used since the 1950s to describe the fundamental concepts and problem-solving skills derived from computer science. Papert in 1980 [1] predicted that computational thinking could change the way children think across domains. In fact, his prediction has indeed been realized, and many researchers today agree that CT is a general ability [2,3] and can be applied to a wide range of fields, including social studies, humanities, and arts [4,5]. Wing [6] first proposed the term CT and mentioned that computational thinking is a problem-solving method. In 2008, it was again stated that operational thinking affects everyone's performance and effort in every field [7]. Computational thinking is an analytical manner of thinking. It is consistent with mathematical thinking for the way that people solve problems. It has something in common with engineering ideas, that is, we can design and evaluate a complex system operating under the constraints of the real world. Although it is generally accepted in the literature that CT involves many skills, such as problem decomposition (decomposing complex problems into simpler problems), pattern recognition (observing trends and regularities in data), abstraction (identifying the general principles), and algorithm design (a step-by-step approach to problem solving), around some problems and challenges, people need to learn how to design an appropriate learning experience for CT capabilities with limited evidence. As for the research and implementation in the classroom, the teaching methods, content, and learning strategies of CT should be adjusted according to the age of students, because the cognitive ability of students changes with age [8]. Related to this, Brackmann et al. [9] pointed out that CT is now used and studied in schools through two main methods: computer programming exercises (plugin activities) and unplugged activities. The main difference between these two types of activities is the latter's method of exposing students to CT without using a computer [10–13].

However, there are few studies on the training of computational thinking ability in the course at present [10–12]. The research of this computational thinking often lacks a logical process to introduce it into the university curriculum. The balance scorecard (BSC) is a concept developed by Kaplan and Norton [14,15]. The concept has been successfully applied in the service industry, government units, non-profit companies, and other industries [16–18]. The current work integrates a computational thinking process into a course using a BSC. It is meaningful to use a BSC as an educational tool, because it can evaluate financial and non-financial indicators and enables students to establish quantitative and non-quantitative measurement benchmarks among different functional management areas. Students' academic performance is like financial indicators in management, while the learning process is like non-financial indicators. The learning process includes team cooperation and interaction. It can represent the process of operational thinking, teach students how to think and interact, and then promote students' performance. Therefore, a BSC assists operational thinking to construct a logical process.

Computational thinking course design aims to promote teamwork and help students to provide opportunities to cooperate with students from various backgrounds. However, in the past, there was a lack of an effective management tool to achieve such goals. With the invention and development of information technology, the environment that teachers are facing today is quite different from that in the past. These environments include students from diverse backgrounds and students' degrees are often different. Teachers undoubtedly face more challenges in the teaching process. University teachers must make full use of management tools to create teaching synergy. This paper fills the gap of computational thinking through a BSC, with indicator measurements, and we found essential ways in which logical thinking has been greatly integrated into training courses for students' computational thinking and working style.

This paper is organized as follows. Section 2 introduces computational thinking. The questionnaire technique used to attain computational thinking criteria and factors is presented in Section 3. In Section 4, we infer the development procedure of the BSC project with the empirical results of computational thinking through the BSC framework and illustrate a simple example to conduct the computational thinking. Section 5 presents our conclusions and suggestions.

2. Literature Review

2.1. Computational Thinking

Computational thinking (CT) is a common skill in our lives or work; it is no longer stereotypically only required by computer engineers. Wing [1] first proposed CT in 2006. He mentioned that computational thinking is one way to solve problems. Furthermore, it was stated again in 2008 that computational thinking can affect everyone's performance and efforts in each field [2], and that is why we should carefully review our education and teaching methods to meet new educational challenges. When the National Research Council of the United States held a conference to discuss computational thinking in 2010, it listed the relevant skills that computational thinking may include: problem abstraction, problem decomposition, reasoning, and computer science concepts [19]. Brennan and Resnick [20] described the key dimensions of the CT framework: computational concepts, computational practices, and computational perspectives, and after evaluating how these dimensions are developed, proposed a set of learning recommendations for evaluating young people studying programming. When students learn programming, they also need to use computational-thinking-related methods to solve problems through the process of abstraction, disassembly, design, and evaluation [21].

In recent years, computational thinking has gradually been recognized as an important skill for students in learning computer science and other subjects. Although this field has always attracted much attention, it is rarely taught as a formal course. There is no standard to evaluate what computational thinking is and how to teach it. However, the operation of CT can be divided into two categories: The first category is the definition of programming and computing concepts explicitly related to the learning and practice of CT through programming [22–24]. The second category is the position of CT as a capability and a problem-solving process, characterized by finding effective solutions through logical organization, analysis of data, use of models or simulations, etc. [25,26]. Therefore, no matter which category, the problems encountered in various fields can be solved through the framework of CT.

Lee et al. [27] proposed the computational thinking framework of "use, modify, and create" to represent the three stages of students' cognitive and practical activities and develop a learning environment more suitable for computational thinking, hoping to help more students. del Olmo-Muñoz, Cózar-Gutiérrez, and González-Calero [28] assessed whether unplugged activities are beneficial to the early primary education of CT. To this end, a quasi-experimental study was carried out to explore the ultimate benefits of a hybrid approach combining unplugged and plug-in activities. In this event, three questions are analyzed and raised by three different terms: before teaching, during teaching, and after teaching. It was concluded that, considering CT, motivation, and gender, it seems beneficial to include unplugged activities in teaching. The study proposed by Wei, Lin, Meng, Tan, and Knog [29] examined partial pair programming pupils, CT skills, and self-efficacy (SE). The effectiveness of the research results showed that in 12-year basic education, programming teachers can use partial pair programming to improve students' CT skills and programming SE.

Zhang et al. [30] proposed a flow chart progressive thinking training method to cultivate students' computational thinking ability. The experimental results showed that the academic performance of the experimental group was significantly higher than that of the control group. At the same time, the programming self-efficacy of the experimental group was significantly improved. In addition, participants in the experimental group demonstrated higher levels of computational thinking skills, including cooperative learning, critical thinking, and problem-solving skills. The study [31] developed a scale to determine the programming-oriented computational thinking skills of university students. The scale consists of 33 items under conceptual knowledge, algorithmic thinking, and evaluation subscales. Experimental results show that programming experience has a significant impact on conceptual knowledge, algorithmic thinking, and evaluation. There are significant differences in algorithmic thinking abilities among students with low-, middle-, and high-level programming experience.

2.2. Balanced Scorecard (BSC)

The balanced scorecard (BSC) was first proposed by Kaplan and Norton [14]. This model can measure the functions of an organization from financial and non-financial perspectives. The BSC is a strategic planning and management system, which is widely used in government, industry, business, and non-profit organizations around the world to align business activities with the organization's vision and strategy, improve internal and external communication, and monitor the organization's performance in accordance with strategic goals [15].

Kaplan and Norton [14] suggested that managers can consider their strategic measures as a set of causal relationships among aspects of the BSC, rather than as performance factors on independent dimensions. They proposed a strategy map to enable managers to understand how the performance in each dimension follows a hierarchical structure. Improvement in learning and growth leads to better internal processes, enhanced value proposition to customers, and ultimately financial performance. Figure 1 shows these relationships between BSC dimensions. Kaplan and Norton believe that the strategic relationship among the dimensions can enable managers to examine strategy. For example, investment in sales (learning and growth) via the Internet can complete sales faster and more accurately (in terms of internal processes). It can increase market share (on the customer side) and thus bring in more profits (on the financial side). This study emphasizes how to introduce computational thinking into the BSC framework. The initial aspect of the BSC is learning and growth. The learning process includes team cooperation and interaction. It can represent the process of operational thinking, teach students how to think and interact, and then promote students' performance. Therefore, the BSC assists operational thinking to construct a logical process.

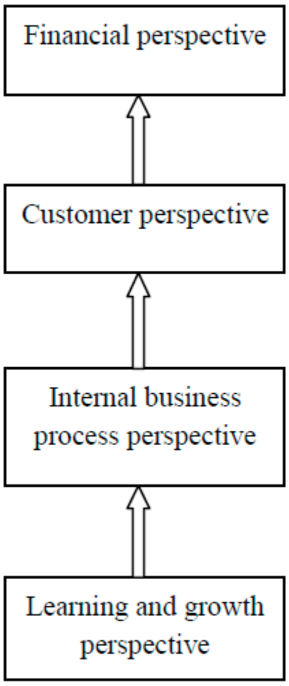


Figure 1. The causal relationships among BSC's perspectives.

Mio [32] used the balanced scorecard for sustainability (SBSC) as a performance measurement and management control tool that plays an important role in driving companies to achieve sustainable development goals. Specifically, it addresses the determinants of SBSC use, the approach companies take in SBSC application, and the results it produces in terms of its impact on sustainability control and management. The authors [33] aimed to assess the current state of research using the SBSC as they relate to outcomes related to environmental performance. It also attempts to propose a conceptual framework that presents the relationship between SBSC and environmental performance. The paper also highlighted that SBSC knowledge plays a mediating role in the above relationship. Furthermore, based on expert competence theory, the presence of experts may moderate the relationship between SBSC architecture and environmental performance outcomes.

Kaplan and Norton [14,15] introduced the BSC and its four perspectives to attain enterprise performance. It is a management framework that integrates strategic performance and can help organizations articulate, communicate, and translate strategy into action. The current study adopted the BSC framework in our computational thinking courses to emphasize the key role played by computational thinking in influencing and assessing learning performance from the four perspectives outlined by the BSC, as shown Table 1.

Balaji et al. [34] showed that supply chain management plays an important role in improving organizational efficiency and effectiveness. Designing a supply chain may not be enough to improve an organization's overall performance, which can only be improved through evaluation. In addition to the supply chain operations reference model (SCOR), analytic hierarchy process (AHP), data envelope analysis (DEA), and heuristic-based models [16,17], the balanced scorecard (BSC) is a suitable tool. Addressing this ambiguity and improving supply chain performance using the balanced scorecard model is the focus of the current research effort by providing a way to examine value creation from four perspectives:

financial, customer, internal business process, and learning and growth. Camilleri [35] presents a critical review of the relevant literature on managerialism in higher education. The interpretative study relied on the BSC approach as it appraised the participants' opinions and perceptions. The findings revealed the strengths and weaknesses of using the BSC's financial and non-financial measures to assess the institutional performance and productivity of individual employees. Based on this connection, we aimed for this paper to link the application of BSC in higher education to the CT course.

Table 1. The four perspectives of the BSC framework.

Perspectives	Objective	Measure
Financial	How do we look to shareholders?	The financial view covers the income in terms of sales growth, profitability, and cash flow.
Customer	How do customers see us?	Customer views reflect measures to provide customers with differentiated value.
Internal business	What must we excel at?	The internal business view focuses on key business processes in order to satisfy customers and shareholders.
Innovation and learning	Can we continue to improve and create value?	The point of view of innovation and learning is to address the need for an organizational climate that promotes knowledge and innovation by strengthening human resources and information technology.

Therefore, referring to the computational practice in the key dimensions of the CT framework proposed by Brennan and Resnick [20], we aimed to lead students to construct a problem-solving process and, through cooperation among group members, constantly think, realize, test, rethink, re-realize, and test again. By repeating this process over and over, the team can gradually refine its solution to the problem. Finally, through the integration of the BSC performance evaluation tools, the overall knowledge and understanding of students' team learning can be enhanced. We designed and implemented a computational thinking project into BSC and posed simple questions about a triangular figure to practice the computational thinking procedure.

3. Methodology

3.1. Research Hypothesis

The importance of designing interest-oriented computational thinking courses is proposed by Kong, Chiu, and Lai [36]. This type of course aims to improve students' creative self-efficacy and provides opportunities for cooperation. Teachers need to adopt strategies to increase their interest in programming. Future research can evaluate whether courses incorporating collaboration opportunities can enhance students' interest and ability in programming. Schröder-Hinrichs [37] designed a positive spirit of teamwork and provided students with opportunities to cooperate with students from different backgrounds. He found that students who were more active in cooperative attitudes had a greater sense of creative self-efficacy. Otheitis and Kunc [38] presented a method to help businesses develop their relationship models and understand them, and they proposed systematic thinking as a way to achieve these goals. A BSC helps enterprises outline the methods to achieve their goals. Relatively, a BSC can also be used in computational thinking courses to construct a set of methods to achieve their learning process. The research framework is shown for Figure 2.

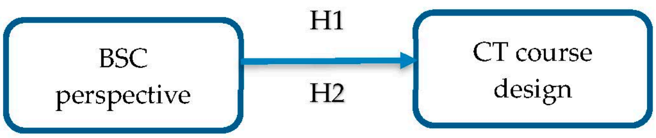


Figure 2. Research framework.

These characteristics are classified in training and are satisfactory so as to benefit each other and improve the overall performance of the organization. The expected results can be presented in the form of two hypotheses:

Hypothesis 1 (H1): *The BSC significantly improves students' perception and understanding of computational thinking processes.*

Hypothesis 2 H2: *The BSC significantly improves students' perception of how computational thinking promotes each other and teamwork.*

3.2. Project Development Discussion

After graduating from junior high school, students in Taiwan's education system can enter ordinary senior high schools or junior colleges. Junior colleges refer to five-year junior high schools, which enroll junior high school graduates. Through junior high school education examination, each department of junior college takes entrance without examination as the main recruitment channel. This study involves a computational thinking course for the first year of the five-year junior college. The goal of the course is to make students get used to finding solutions in a systematic way. At the beginning, it will take a lot of time for students to get used to; however, as long as they are gradually familiar with the whole process, this course is sure to be able to teach and develop a set of solutions for their own problems. The course content includes exercises of various types of questions, Sudoku games, and program logic analysis.

First of all, we first designed a theme of computational thinking for this project. The theme content includes exercises, such as various types of questions, Sudoku games, and program logic analysis. College students were invited to participate in an experimental study. This project used a balanced scorecard as a system of functional areas that work together to enhance the learning effectiveness of computational thinking. There are two classes with 58 students each. One class of 58 students (50%) completed the BSC project and agreed to further participate in the pilot study. All participating students have completed the BSC project, which is part of their grading course requirements. In the BSC project, students answered questionnaires and passed qualitative reasoning questions. The development of the BSC project considered computational thinking learning results, which ensures the BSC project is successful. In addition, some factors to consider include student expertise, course structure, teamwork, and teacher network. Adjusting the advantages and disadvantages of the BSC project strategically helps to enable students' positive experience and computational thinking abilities.

At the beginning of the course, participants completed an online questionnaire so we could understand their views on the BSC project as well as to help them to understand the overall concept of computational thinking and the functional areas. The questionnaire scale consists of 10 questions. The 5-point Likert scale ranges from 1 (strongly disagree) to 5 (strongly agree). In addition, the questionnaire obtained demographic information, such as profession and gender, which is very important.

As shown in Table 2, we found that 58 students answered less than three of the ten questions before conducting computational thinking. It shows that students lacked the willingness and ability of thinking and teamwork. When measuring the research dimension, the reliability test method of the Cronbach alpha was used to measure whether the attributes are consistent and reliable. A summary measure of the correlation that exists between items is provided by the coefficient α. Table 2 shows the reliability test results of respondents' views on the 10 items of the Likert type scale. The reliability values of all inspection items are far higher than 0.7, which is considered to be sufficient in basic research to achieve a satisfactory level of reliability [39]. We believe that participation in the BSC project can increase students' understanding of how computational thinking promotes themselves, other students, team cooperation.

Table 2. Frequency, means, standard deviations and reliability of students observed.

Item	Question	F	M	SD	α
1	When discussing problems with people, I always know clearly what they want to express.	34	3.48	0.72	0.86
2	I am a person who enjoys sharing ideas with others.	33	3.60	0.97	0.74
3	When I have a problem, I can always come up with a solution.	23	3.27	0.70	0.90
4	I've always been able to work out a set of simple and easy to understand methods for dealing with complex problems.	19	3.13	0.81	0.91
5	I'm good at writing. I can easily write an article.	4	2.20	0.91	0.89
6	I always listen patiently to what others want to say and express.	44	3.87	0.72	0.81
7	I always have patience to explain and explain what I want to express.	29	3.42	0.95	0.86
8	When I encounter something I don't understand, I will be brave to ask questions and seek solutions.	17	3.05	0.83	0.86
9	Usually, I always record what I see, think of and hear.	11	2.67	1.07	0.75
10	Usually, I like to observe surrounding affairs and try to think about solutions to problems.	32	3.53	0.90	0.81

Note: F = Frequency of more than 3; total of 58 students to answer questions; α = reliability.

4. Empirical Results

For the reliability and validity analysis, the reliability of this paper applies Cronbach's α to measure the consistency of each variable. If the value of Cronbach's α falls between 0.7 and 0.98, the variable has a high level of reliability; if the value falls lower than 0.35, the variable must be deleted. After conducting reliability analysis, the average value for each variable reaches over 0.8, and they therefore have a high reliability value. Table 2 shows the reliability analysis results for each variable and factor. The questionnaire of this work has a theoretical foundation or practical verifications that were developed by foreign scholars conducting studies. Hence, the current study contains reasonable content validity.

4.1. Integrated BSC into Computational Thinking

This work applies the four perspectives of the BSC to computational thinking teamwork. Computational thinking courses should also start from the perspective of BSC learning and growth. The reconstruction of computational thinking can enhance students' learning level and performance, and can evaluate students' performance foundation through autonomous learning. Similar to the BSC, as employees learn and grow well, organizations can improve internal processes, such as teaching computational thinking in college courses. Students can play a role in autonomous learning if there is an ability to read, and a lot of information can be immediately found. Similar to the perspective of the BSC framework, internal processes can improve customer satisfaction. Students can solve difficult problems by decomposing several steps through computational thinking. Finally, the goal of the BSC is the financial performance of the enterprise, and the learning achievement of the CT course is just like the financial dimension of the BSC. The course learning achievement records the problem-solving process through computational thinking.

From the perspective of the BSC, we can connect the cause and effect of non-financial indicators and financial indicators. The design of a relative CT course can also be divided into final learning achievements (financial indicators) and learning processes (non-financial indicators). CT could determine the process of students solving problems and obtaining test scores. The concept of the BSC can promote the process of students' understanding of CT. It can give students a better understanding of how to solve problems in facing difficult situations; see Figure 3.

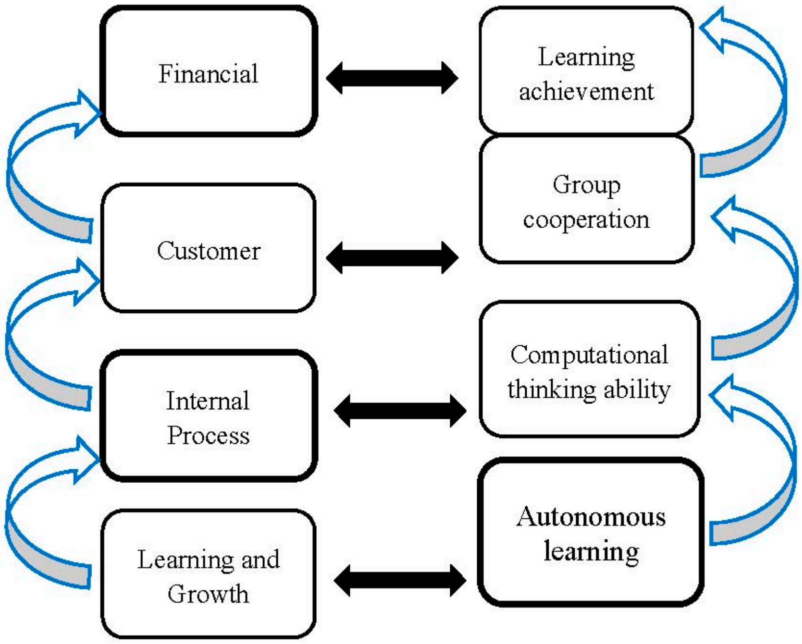
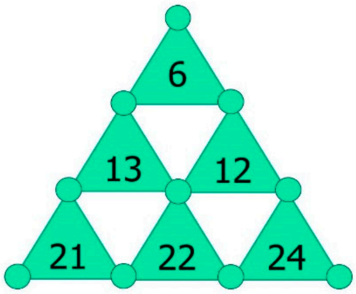


Figure 3. BSC integrated into computational thinking.

In order to fill the gap between theory and practice, Figure 3 shows a causal analysis of the reconstruction of computational thinking. Initially, in students' spare time, they surf the Internet or read books related to thinking (employee learning and growth). When students face the problem, they think about the possible solutions and write them down (internal processes). In the process of discussion, students always patiently explain the things they want to express to people (customer). This computational thinking course teaches students to come up with more possible solutions (financial). The above process represents the point of view of the BSC so that all students are aware of the causal relationship between the BSC and the computational thinking framework.

After designing a computational thinking framework from a BSC perspective, we integrated the BSC and CT frameworks into the process of teamwork analysis. Improving student problem solving through teamwork cooperation is indispensable and essential in a computational thinking course to promote logical thinking, avoiding repeat errors, and enhance computational ability. This computational thinking learning process mainly aims for educators to reconstruct the process of curriculum development, curriculum optimization, and teamwork through a BSC causal relationship, as shown in Figure 4.

Q1 assumes that there is a figure as follows:



- *The number in the triangle is the sum of the circle numbers of the three vertices of the triangle. There are 10 vertex circles in the graph, and only 1, 2, 3, and 10 can be filled in, and the numbers cannot be repeated. How many are they, please?*

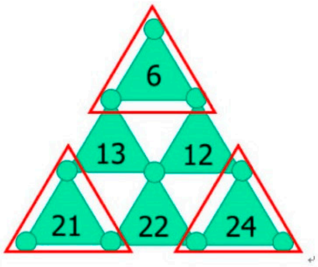
Computational thinking process is as follows:

1. ***Autonomous learning***

Which is better to decompose from bottom to top or from top to bottom?

If it's not easy to deal with, what's special about it?

The top, bottom left and bottom right triangles contain no repetition of nine vertex circles.



2. ***Computational thinking ability***

After getting the unique number of vertex circle in the middle is 4, let's take a look at the triangles related to vertex circle 4, which are three vertex circles and 13, 12 and 22 respectively.

***Step 1**:*

If we expand from the triangle whose sum is 13, then the sum of the other two vertex circles is 9 (= 13-4), but the sum of the two vertex circles equals to 9 is too many combinations, including 1 + 8, 2 + 7, 3 + 6, 4 + 5, 5 + 4, 6 + 3, 7 + 2 and 8 + 1. Therefore, the derivation from this triangle will lead to too many combinations and complexity. Similarly, if we expand from the triangle with the sum of 12, there are still many kinds of combinations.

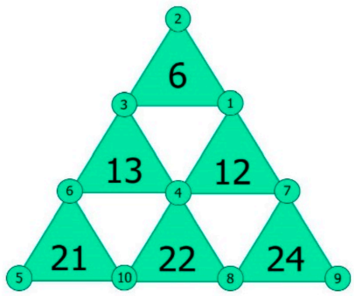
Figure 4. *Cont*.

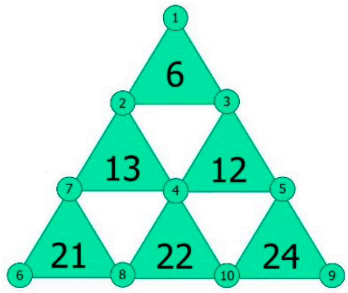
Step 2:

Next, let's look at the triangle with a total of 22. The sum of the two lower vertex circles is 18 (= 10 + 8 = 8 + 10). There are only two kinds of combinations, which are much less than the two triangles in the front.

3. *Group cooperation*

After group discussion through team cooperation, we can get the result of the left figure below by the combination of 10 + 8. Expand by the combination of 8 + 10, you will get the result of the right figure.





4. *Learning achievement*

This simple example has taught students the skill of problem thinking and no longer afraid to deal with similar problems.

Figure 4. Simple computational thinking theme integrated into BSC procedure.

4.2. Designing Computational Thinking Course through BSC Perspective

In order to allocate resources related to the BSC project, the management of the course is used to publish a large number of resources, such as:

(a) Examples of a balanced scorecard;
(b) Scorecards of different industries for comparison;
(c) Project description;
(d) Project team business contact information;
(e) Project calendar.

Through the BSC project, we developed CT teaching materials. Through the design of the BSC, we taught students the procedures of team cooperation, as shown in Table 3.

As can be seen in Table 3, the BSC project needs time to introduce the BSC concept and team introduction. The BSC framework should be introduced in class before student groups begin to study their balanced scorecard projects. The BSC can be introduced at any time during the course. The teacher restructured the computational thinking curriculum for freshmen around the four aspects of BSC, and introduced the framework and four aspects of BSC in the first class. With the understanding of the structure of the whole course, even traditional programming topics, such as programming languages, can be discussed within the framework of BSC's four perspectives. The 14-week sample syllabus uses the BSC as the learning evaluation, as shown in Table 3. The total classroom time for a balanced scorecard project obviously depends on teamwork and presentation duration.

Table 3. Design of computational thinking course through BSC perspective.

Perspective	Course Arrangement	Concrete Practice
Autonomous learning	Self-practice and thinking	In my spare time, I will try to think about various problems.
		In my spare time, I will download app related to Computational Thinking to train myself.
		In my spare time, I will spend more time thinking about problems.
		In my spare time, I will surf the Internet or read books related to thinking.
Computational thinking ability	Decomposition process	When the problem is more complex, I will try to break the problem into several small problems for easy solution.
		When I see the problem, I think about the possible solutions and write them down.
		If I encounter any problem, I will try every means.
Group cooperation	Learning and imitation	I'm going to observe the way the team members express themselves.
		I will go to learn the problem-solving or explanation methods of more powerful team members.
		I always listen patiently to what others want to say and express.
	Share and express	I always have patience to explain and explain what I want to express.
		During the discussion, I am a person who is willing to share my ideas.
Curriculum learning achievement	Certificate examination	This course has taught me the skill of problem thinking.
		This course makes me no longer afraid to deal with problems.
		This course has taught me to come up with more possible solutions.
	Semester results	This course gives me a better understanding of how to carry out problems in other courses
		In the future, I will consider taking professional technical courses related to computational thinking.

4.3. Teaching Instruments and Course Plan (Formal Courses)

Table 4 shows the teaching materials and content used in CT courses. The most commonly used is the programming design course, which takes 18 weeks and earns students two credits per semester. The course is arranged to help students complete CT activities through experiments and playing online games. At the same time, robots, game competitions, videos, or other materials are also involved to train students' CT ability. Table 3 can demonstrate how the BSC assists the CT course arrangement for 18 weeks through four steps: autonomous learning, computational thinking ability, group cooperation, and learning achievement.

Table 4. Teaching materials and content in CT course.

Week	Topic	Level of Detail	Complementing Item
1	Introduction		Test 1 Initial questionnaire
2	Step 1: Understanding problems	Lead students to understand the logical relationship between the description of the problem and how to find the key points in the problem.	BSC integrated into computational thinking: **autonomous learning**
3	Step 2: Find a way	Try to find out possible solutions according to what you have learned. You don't care about the processing efficiency of the method, but only care whether the problem can be solved.	BSC integrated into computational thinking: **computational thinking ability**
4	Step 3: Confirm the results	According to the proposed solution, the problem is solved in practice and the result is confirmed to be correct.	BSC integrated into computational thinking: **group cooperation**
5	Step 4: Share the results	(1) The results are the same, but the methods of solving problems are different. (2) Students can share on stage to make themselves more clearly confirm whether they really understand and can clearly describe to others.	BSC integrated into computational thinking: **learning achievement** (Students share individual problem-solving methods and learn more about the way to solve problems).
6	Question exercises	All kinds of exercises are standard answers as long as they can be solved.	Collaboration discussion, Brainstorming
7			
8			
9	Mid-term exam	Oral or pen and paper test	
10	Question exercises	All kinds of exercises are standard answers as long as they can be solved.	Collaboration discussion, Brainstorming
11			
12			
13	Video appreciation, robots, games competition	How the protagonist can deal with problems in the competition of video or games so that students can learn various possible methods in a relaxed atmosphere.	Four steps of BSC to help students solve problems
14			
15	Question exercises	All kinds of exercises are standard answers as long as they can be solved.	Collaboration discussion, Brainstorming
16			
17			
18	Final exam	Oral or pen and paper test	Test 2 Final questionnaire

As seen in Table 3, regarding the questionnaire item for designing a computational thinking course through the BSC perspective, 58 students (50%) completed the BSC project and answered the questions in Table 2. The results in Table 5 show that the integration of the four CT perspectives of the BSC explains the significant differences in CT objects, and H1 is supported: the BSC significantly improves students' perception and understanding of the computational thinking process. Students can obtain self-practice and thinking to solve any complicated problems through the learning and internal processes of BSC perspectives. In Figure 3, the computational thinking process is formed from with the BSC and it reconstructs the process of curriculum development. H2 is supported: the BSC significantly improves students' understanding of how computational thinking promotes themselves, other students, and teamwork. Students can learn and imitate to observe the teamwork cooperation through sharing and discussion about logical thinking problems. Therefore, we suggest that, in the information management course, we should also cultivate students' logical thinking ability, help them understand the causal relationship, and provide the basis for the future conceptual thinking course arrangement, in addition to training information professionals.

Table 5. Regression analysis of conceptual thinking and learning outcomes.

Variables	*B*	*t*	Significance	Hypothesis
Constant	0.372	0.423	-	-
Autonomous learning	0.125	2.125	***	H1
Computational thinking ability	0.276	2.573	***	H1
Group cooperation	0.328	3.281	***	H2
Course learning achievement	0.451	4.387	***	H2

Note: *** shows $p < 0.005$.

5. Conclusions and Suggestions

5.1. Conclusions

Several past studies have found that managers lack a basic understanding of the BSC method [40–44]. Our paper reports an experience method of learning CT by studying BSC performance evaluation tools. The BSC project provides students with practical experience in cross-functional, team-based, and conceptual thinking. The project aims to address several educational objectives, including improving student problem-solving through teamwork cooperation, promoting logical thinking, avoiding repeat errors, enhancing computational abilities, and developing oral presentation and teamwork skills.

Our results correspond to Hunt, Taylor, Winter, Mackie, and Fisher [45]. In order to confirm students' understanding of the business function domain, Hunt et al. [45] assigned BSC projects to students in basic courses and completed a survey to determine whether BSC enhanced their knowledge and understanding of business disciplines within the organization. Therefore, because the balanced scorecard can improve the learning effect, we conducted a study to help improve students' cognition and understanding of the importance of computational thinking. We hypothesized that BSC would significantly increase students' awareness of mutual benefit and teamwork in computational thinking and functional areas. The survey results show that the BSC project has a positive impact on the participating students, indicating that their overall knowledge and understanding of the functional areas and relationships in teamwork have been enhanced.

5.2. Contributions and Future Directions

This paper has several advantages over the existing BSC case studies in the literature because it encourages students to think first before proceeding with subsequent process. The experiential approach requires each student to compose a team, find information about their motivation, and develop BSC concepts that apply learning performance in a computational thinking course. To achieve this, we recommend that lesson plans should include functional areas and a manner for how each functional area affects the tasks of teaching arrangements. All four assessments of a BSC project—financial, customer, internal processes, and learning and growth —should be taught. This study can integrate the four aspects of BSC and CT to evaluate students through four perspectives: autonomous learning, computational thinking ability, group cooperation, and curriculum learning achievement. Enhancing students' logical thinking is essential for maintaining competitiveness. This BSC framework mainly requires educators to redo curriculum development, the development of colleges and universities, and the technical specifications of the convention. The theoretical implication is that BSC can not only be used as a performance management tool, but can also be used to further achieve students' learning results in CT courses.

The research limitation in this study is the measurement of the computational thinking course, which is mainly based on the number of small classes. If we can expand to a larger number of samples and fill in the quantitative questionnaire, we can understand the causal relationship between variables. As long as it is carefully designed, implemented, and evaluated, the BSC project has great potential. Therefore, it is possible to provide a summative assessment in the first year of the school's preliminary courses, and to promote students' knowledge and understanding of computational thinking innovation. This paper can help related university educators establish computational thinking courses to enhance student competitiveness and construct problem solving approaches for professional abilities to be applied throughout the BSC. BSC is a comprehensive tool that allows teachers and students to perform in the teaching scene and can have a significant impact on their university education and learning, which can affect their future careers.

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