

Article

Is Mathematics Required for Cooking? An Interdisciplinary Approach to Integrating Computational Thinking in a Culinary and Restaurant Management Course

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Abstract: In recent years, with the flourishing of the catering economy and the trends in computer technology, restaurant operators have increasingly relied on employees with computational and information skills. Breaking through the traditional teaching method of mere lecturing, the study conducts a teaching demonstration by integrating the computational thinking concept and a Microsoft Excel computational system on the school's E-learning platform into the teaching of a Culinary and Restaurant Management course. A non-equivalent control group pretest–posttest study with a quasi-experimental design is adopted for the assignment of experimental participants and the design of the course. The results show that a curriculum design with computational thinking significantly improves the effectiveness of students' learning in digital technology and is especially helpful for the cultivation of the key capabilities of menu design and cost planning among restaurant management skills. The study makes the following contributions: during the Culinary and Restaurant Management course, the use of the E-learning platform and computing programs such as Microsoft Excel is associated with greater learning effectiveness than traditional teaching methods. The research results can serve as a reference for promoting an E-catering business model and a sustainable educational model in the future.

Keywords: technologies for mathematics; computational thinking; training and education applications; culinary and restaurant management; information and communication technologies



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1. Introduction

1.1. Research Motivation

Due to the current boom in the economic environment, market competition and diversified operational strategy requirements in the catering field, many catering businesses have higher expectations of new employees than ever before [1]. In this highly competitive industry, catering businesses are increasingly relying on employees with diverse E-skills [2]. Therefore, these enterprises are searching the most skilled and experienced employees [3]. Accordingly, with the flourishing of the catering economy, the demand for labor in the catering industry is huge. However, the catering talents cultivated in the general catering vocational education system do not meet the needs of the industry, indicating a gap between school learning and real-life practices and showing that the cultivation of catering professionals does not meet industry expectations [1]. Therefore, methods for reducing the gap between learning and real-life practices and cultivating the talents needed by the catering industry are crucial topics that must be urgently addressed by the catering academia [4].

With the rapid development of information and communication technology (ICT), life has become full of various digital products. Wang [5] claimed that the use of digital tools is an indispensable basic skill for modern people. It is obvious that the use of digital computing tools has gradually become a basic life ability that modern people must possess. According to many previous articles, the promotion of ICT-based teaching has become a trend in current education [6–8] and Ketelhut et al. [9], Yadav et al. [10] and Hsu et al. [11] indicated that diverse teaching designs and strategies can be utilized in various teaching fields to cultivate students' computational thinking. We should foster not only students' capacities in reading, writing and mathematics but also their practical abilities in computational thinking and E-learning skills [12]. The concepts of E-learning and computational thinking are considered key skills that students should possess in the 21st century to develop the ability to solve problems according to the principles of computational science [13–15]. Li et al. [7] believes that ICT learning can contribute to the cultivation of computational thinking and that such thinking ability can be applied to various fields.

Hsia et al. [4] pointed out that, in an environment of rapid economic development and increasing consumer demand, the catering industry continues to develop and to face new challenges. In the era of mobile Internet, digital tools continue to emerge and unique functionality has become a major boost in the development of various industries. Following these general trends, the catering industry must use the intelligent technology of computational thinking to improve competitiveness, reduce costs and increase revenue. Therefore, it has become a main focus of catering education to strengthen students' basic catering management skills, computational and information capabilities and data-oriented scientific acumen, so that they can become well-rounded catering management professionals [16–18].

Vogel et al. [19] proposed that modern catering courses must adopt a broader perspective in evaluating culinary education. School curricula should promote self-learning among students and cultivate their professional skills in catering and culinary arts, as well as their independent research capabilities, to establish multipurpose E-learning courses. The inclusion of ICT as a major area of catering education demonstrates the importance of digital technology to future catering education. Furthermore, the catering industry and technical and vocational education must not only cultivate the professional knowledge of employees and students but must equip students with the ability to apply technology, solve problems and innovate [4,20]. Therefore, the use of E-learning and the integration of computational thinking have become a popular trend in schools.

In the past, most of the teaching methods used in the Culinary and Restaurant Management course used general teaching and demonstration methods and emphasized cooking practice exercises. For example, the teaching site is to practice cooking techniques in the kitchen. There are few cross-fields combined with electronic media to use the E-learning learning system and Microsoft Excel computational system for teaching. The traditional teaching methods of general cooking techniques mostly focus on lectures and demonstration teaching. Students start cooking practical exercises after the teacher has taught the topic. Students are not exposed to the new trend of computing thinking technology in the catering industry, but only learn the cooking skills brought to them by traditional teaching methods. However, they have not learned that using Microsoft Excel computational system can help them use their high-level thinking skills in projects such as menu design and cost planning and food specification computation and help them prepare the basic skills needed for employment in the future.

In summary, this study applies the concept of computational thinking and the Microsoft Excel computational system in the school's E-learning platform to integrate E-learning into the Culinary and Restaurant Management course. This approach represents a break from the previous teaching mode of lecturing alone. Innovative teaching materials and methods are used to integrate computational thinking and Microsoft Excel into the curriculum and simulations of actual restaurant management are applied to create a good

E-learning course design and benchmarks. The results provide us a reference for education and training programs for catering educators and catering business operators.

1.2. Research Objectives

1. By using the school's E-learning platform, this study integrates the computational thinking concept and Microsoft Excel into the experimental teaching of the Culinary and Restaurant Management course.
2. This study analyzes the learning effectiveness of students who take the course with the integration of computational thinking and Microsoft Excel.

2. Literature Review

2.1. Talent Cultivation in Culinary and Restaurant Management

Excellent culinary skills have always been a significant factor in restaurants' ability to attract customers. Therefore, businesses and schools should not abandon courses that teach practical culinary skills [16]. Airey et al. [21] pointed out the changes in the demand for professional abilities in the catering industry in recent years and indicated some of the reasons why it is difficult for school programs to meet the needs of the industry. First, employees need to learn skills and knowledge in different fields to be able to work competently under dynamic conditions. Second, various companies and managers have different requirements for and understanding of skills. In a modern society in which knowledge develops and is accumulated rapidly, it is not uncommon for the skills and knowledge taught in schools to fail to meet the needs of industry after students graduate. Third, the complexity of the work has increased over time and the range of abilities required to hold a position has expanded considerably. Fourth, the intensive and long-term programs of schools produce students capable of high-level employment; however, the industry's demand for high-level employees has not increased. In addition, some scholars have pointed out that sought-after skills for employees in the catering industry have gradually undergone fundamental changes. There have been many discussions of what competencies students must possess to succeed in the workplace [21–23].

Nachmias et al. [22] stated that in the training of restaurant management talents, culinary skills still have an irreplaceable position. Fong et al. [24] and Alexakis and Jiang [25] believe that food and beverage management departments should reflect on the content of the courses they provide and consider whether the courses are designed to meet the real needs of the food and beverage industry to achieve appropriate differentiation. If the course content offered does not differ much from that of a business school, students could choose the business school instead and the unique aspects of studying in the food and beverage management department would not be recognized. Marneros et al. [26] studied the skills and knowledge required by hospitality management graduates and the content of the courses that students should take to be prepared for a restaurant positions; those authors found that graduates should have catering management skills, financial management skills, problem-solving abilities, creativity and flexible thinking. Askren and James [1] and Binder et al. [27] specifically mentioned the contradiction between the rapid development of technology and business models in recent years and the excessively long education cycle in schools. When schools lack the capacity to internalize and organize knowledge into curricula, it is likely that the courses they teach are outdated and do not meet the needs of the industry. This is a problem that all teaching units should consider and is a reason why students cannot apply what they have learned.

Courses should be designed and planned based on the professional needs and suggestions of the industry and supplemented by practical catering business courses that incorporate computational thinking to examine whether they are in line with the current professional demands of Taiwan's catering market. For the sustainable development of the technical and vocational education and training in catering in Taiwan, we should apply this development and review process to curriculum development.

2.2. Computational Thinking and E-Learning Course Design

Computational thinking is a mode of thinking that uses the basic concepts of computer science to solve problems, design systems and understand human behaviors [12]. Computational thinking can be simply defined as “the knowledge, attitudes and skills necessary to use computers to solve daily problems [28]”. Additionally, computational thinking is “the basic ability to use information technology or other tools to solve complex problems with efficient strategies [29]”. According to Angeli and Giannakos [30], computational thinking is “a process of thinking that involves generating problems, organizing solutions and expressing solutions in a form that can be solved by computational tools”, while Aho [31] simplified the concept as “expressing the solutions to problems as computational steps and algorithms”.

The Computer Science Teachers Association (CSTA) and the International Society for Technology in Education (ISTE) proposed that, while computational thinking is a necessary ability for the development of computer applications, it can also be used to support problem-solving in all disciplines, including mathematics, science and humanities [32]. Li et al. [7] claimed that computational thinking is generally recognized as problem-solving skills and methods that can be fostered through the study of computer science and applied in various fields. According to Fang and Lee [33], E-learning in Taiwan has undergone many changes, including information education that is oriented toward programming skills, software–hardware applications, problem-solving, computer science and computational thinking. E-learning has developed from an operating skills-oriented mode to a higher order thinking-oriented mode, gradually focusing on the development of students’ thinking ability.

According to Wing [12], computational thinking can be divided into a variety of thinking processes, including abstraction, algorithm design, decomposition, pattern recognition and data representation. In the United States, the ISTE also broadly defines computational thinking as higher-level skills, including creativity, algorithmic thinking, critical thinking, problem solving, communication and cooperation. It is a way of thinking that applies the use of computers to solve problems in life [34]. To respond to changes in the social environment, traditional pen-and-paper education also needs to be reformed. The vigorous development of science and network technology has made E-learning a very popular teaching mode [9].

Bocconi et al. [35] pointed out that countries throughout the world have begun to attach importance to applying the concept of computational thinking to teaching. Experts and scholars in various fields have also put forth different definitions of computational thinking. The National Research Institute and the ISTE in the United States emphasize the significance of computational thinking. It is considered essential to incorporate the concept of computational thinking into the formal curriculum. The UK has implemented a complete set of E-learning courses on computational thinking and has incorporated computer science, information technology and digital literacy into all disciplines [36]. Vallance and Towndrow [37] specified that integrating the concept of computational thinking into the design of curriculum activities and using a school’s E-learning activities for specific learning goals can help students understand how to think and how to develop and apply knowledge. During teaching, teachers and students explain the problem-solving process in detail, including why they choose the solution they did and how they solved the problem.

In summary, this study intends to integrate computational thinking into curriculum and to utilize the school’ E-learning platform to foster students’ computational thinking ability, with the aim of breaking from the previous curriculum design involving culinary practices alone. In this study, computational thinking is combined with the Microsoft Excel computational system and computational thinking and E-learning tools are effectively used for problem solving, co-creation and communication, allowing students to solve problems through the process of abstracting, disassembling, designing algorithms, evaluating and generalizing. By integrating computational thinking into the design of the Culinary and

Restaurant Management course to equip students with high-level cognitive skills, the study expects to close the gap between catering training and the catering industry.

2.3. Teaching with Digital Media

Alberts and Stevenson [38] stated that digital media refers to interactive information exchange and communication media that uses multiple media or a combination of two or more media in computer application systems. Digital media is computer-centric and can simultaneously present text, images, audio and animations. When instruction is delivered through digital media, students make obvious gains in terms of knowledge, attitudes and intentions in relation to food.

Traditional text-based programming design focuses mainly on abstract concepts. For many students, this learning method is challenging and it can easily lead to low interest and fear in learning situations [39]. In comparison, the emergence of the E-visual programming language lowers the threshold of programming learning. Kelleher and Pausch [40] revealed the three common characteristics of the E-visual programming environment: simplifying the programming design process, providing support for students' learning and stimulating students' learning motivation. Selby and Woollard [41] proposed that programming design activities are related to computational thinking ability. While learning programming, students can achieve a complete understanding and application of computational thinking and elements such as disassembly, pattern recognition and abstraction can be included. Regarding the use of E-visualization development tools to learn computational thinking, Schnotz and Bannert [42] and Holmqvist and Wartenberg [43] stated that it is much easier to read graphics than reading texts, which is helpful for the mastery of the entire program structure. Learning with E-visualization is more natural than learning with text only.

Hsu et al. [44] applied visualized E-learning with digital media to teaching culinary courses and found that it improved students' culinary skills during training. Malan and Leitner [45] pointed out that, while learning E-visual programming, students feel like they are playing games instead of writing programs, which can help them understand the concept of programming. In teaching, it is possible to program E-visual language and teach using program blocks to guide students in step-by-step thinking; in this way, students do not have to worry about spelling or grammatical errors and can concentrate on the logic and structure of programming [46]. Edgar Dale proposed the Cone of Experience in his book *Audiovisual Methods in Teaching* in 1954; he explained the learning approach used by ordinary students and provided teachers with teaching media, learning material and principles for selecting teaching modes [47]. According to the Cone of Experience theory, the learning method at the bottom of the cone is more practical and uses more sensory channels, while the learning method closer to the tip of the cone requires more abstract thinking and uses fewer sensory channels. Applying this theory to teaching design shows that audiovisual methods yield better learning results than traditional lectures or demonstrations. Students with more advanced cognitive development are closer to the top of the cone and they primarily use learning methods that involve abstract thinking. When teaching students about their learning attitudes, teachers should operate at the bottom of the cone, using actual experience and teaching by example rather than relying on abstract teaching methods that only focus on theory.

In summary, this study intends to integrate the Microsoft Excel computational system and the concept of computational thinking into the teaching of the Culinary and Restaurant Management course and to use digital media teaching methods to facilitate the cultivation of abilities that meet the needs of today's catering industry. The studies mentioned above defined computational thinking as a group of high-level cognitive skills that can be applied to solve problems in various disciplines and considered it the core ability of college students. However, at present, the catering industry believes that the skills learned in schools are quite different from the needs of the workplace. Therefore, the authors hope that the integration of computational thinking into the Culinary and Restaurant Management

curriculum design can provide students with the E-skills required by the job market and close the gap between catering training and the catering industry.

3. Material and Methods

3.1. Subjects

This study integrated the Microsoft Excel computational system and computational thinking into an experimental teaching design for the Culinary and Restaurant Management course. The main experimental subjects were students at the Chinese Culture University in Taiwan who registered for the course. Due to the impossibility of randomly selecting and assigning the research subjects, a nonequivalent control group pretest–posttest study with a quasi-experimental design was adopted for the assignment of experimental participants and the course arrangement [48]. The experimental design of this study is shown in Table 1. For the same course, 75 students were divided into two groups, with 39 students in the experimental group and 36 students in the control group.

Table 1. Summary of the experimental design.

| Course | Group | Pretest | Number of Students in the Pretest | Experimental Treatment | Posttest | Number of Students in the Posttest |
|------------------------------------|--------------------|----------------|-----------------------------------|------------------------|----------------|------------------------------------|
| Culinary and Restaurant Management | Experimental group | O ₁ | 39 | X ₁ | O ₂ | 39 |
| | Control group | O ₃ | 36 | | O ₄ | 36 |

Note: O₁ and O₃ are pretests; O₂ and O₄ are posttests; X₁ is experimental teaching for a total period of 10 weeks.

3.2. Research Tools

3.2.1. Microsoft Excel Computational System

Excel is a program developed by Microsoft. It is a very popular software package integrated into the current Windows environment (see Figure 1). This experiment focuses on integrating the following three functions of Excel into experimental teaching.

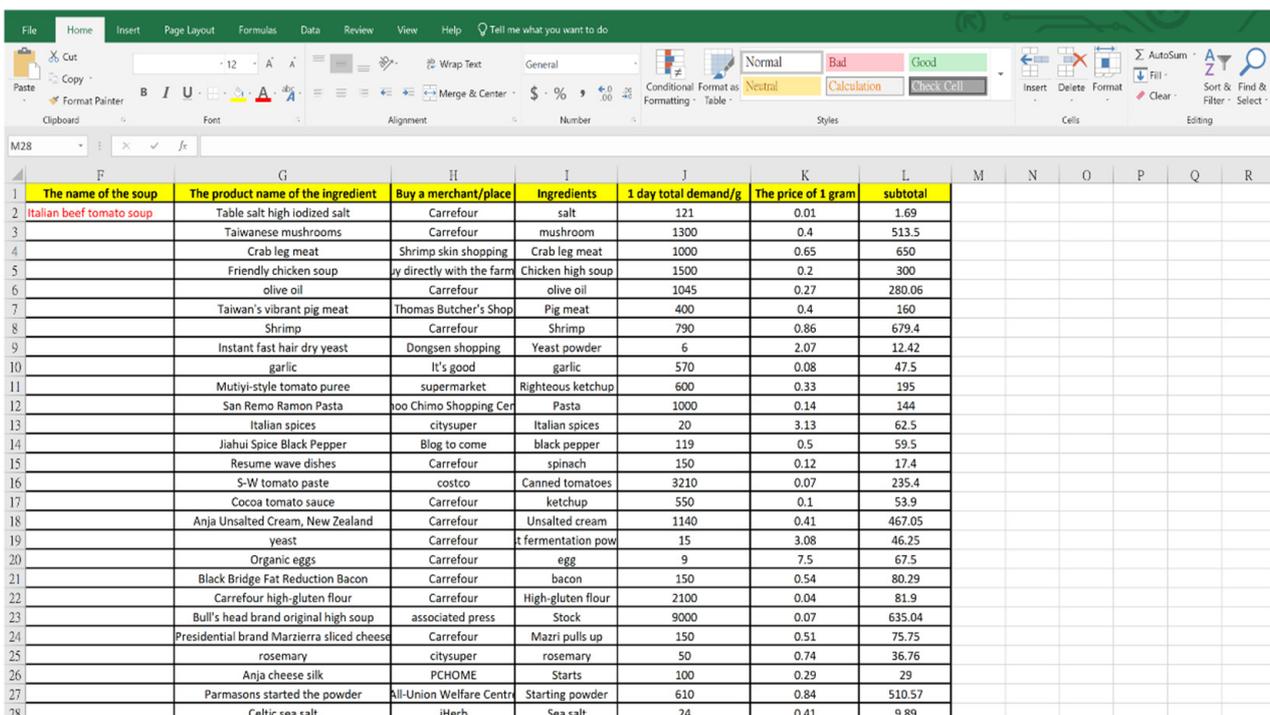


Figure 1. Microsoft Excel system in Culinary and Restaurant Management course.

Spreadsheets

This function includes worksheet creation, data editing (including editing, copying and deleting), calculation processing (including formulas and function calculations), etc. This study applied this function to teach students how to calculate the costs of purchasing restaurant ingredients and the loss during the culinary process.

Statistical Charts

According to the data settings of the worksheets, various statistical charts can be drawn, including line graphs, broken line graphs, three-dimensional graphs, pie graphs, etc. It is also possible to enrich the content of worksheets by adding graphics. This study applied this function in teaching students how to compute the number of restaurant visitors and develop e-marketing programs.

Database

This function includes the creation of data lists, sorting key columns, filtering records that meet certain conditions and performing database management operations, such as "Pivot Table", with the data. The study applied this function to the computational teaching of how to design and plan seasonal menus for restaurants and manage customer digital data.

3.2.2. Computational Thinking Scale

This study adopted the Computational Thinking Scale developed by Korkmaz et al. [49] to measure students' learning effectiveness in computational thinking. This scale has a Cronbach's alpha of 0.822, indicating good reliability and its expert validity was confirmed by five university professors from the Food and Beverage Management Department. Items were scored on a five-point Likert-type scale. The scale includes five subdimensions: menu design and cost planning; food specification computation; computational design and application of catering products; computational thinking and marketing; catering management skills.

3.2.3. Experimental Method

According to Peterson et al. [50], it is necessary to understand students' inherent learning conditions, such as relevant knowledge and performance abilities, before experimental teaching to determine their baseline behavior and use it as reference for designing follow-up teaching and measuring progress. Therefore, a pretest was performed. The pretest was scheduled one week before the experimental teaching began. The subjects of the test were the students participating in the experimental teaching and the control group. A total of 10 weeks of experimental teaching activities in the same course content were implemented. The experimental group focused on catering management and culinary skills supplemented with catering-related computational thinking and literacy teaching and used the school's E-learning platform with digital videos, Microsoft Excel and other computing programs as part of the experimental teaching content. In comparison, for the control group, neither the E-learning platform nor the Microsoft Excel computational system was integrated into teaching. In this study, one week after the experimental teaching, a posttest of both the experimental and control groups was carried out.

3.2.4. Ethics

In the absence of any involvement of therapeutic medication, no formal approval of the Institutional Review Board of the local Ethics Committee was required. Nonetheless, all subjects were informed about the study and participation was fully on a voluntary basis. Participants were ensured of confidentiality and anonymity of the information associated with the surveys.

4. Results

In this study, an independent-sample *t*-test was conducted prior to the experimental teaching to determine whether there were significant pretest differences in learning effectiveness between two groups and explore whether the starting conditions were the same for both groups of students. The pretest mean was used as a covariate and one-way analysis of covariance (ANCOVA) was used to test for differences in the posttest mean scores for the five subdimensions (menu design and cost planning, food specification computation, computational design and application of catering products, computational thinking and marketing and catering management skills) and the total scale score between the experimental and control groups.

4.1. Descriptive Statistics of Pretest and Posttest of Learning Effectiveness

The descriptive statistics of the pretest and posttest learning achievement of the different teaching methods are summarized in Table 2. The results show that, for the 75 subjects (36 in the control group and 39 in the experimental group that received teaching that integrated computational thinking and the Microsoft Excel computational system), the posttest performance was better than that of the pretest and the mean of the experimental group was higher than that of the control group. In terms of standard deviation (SD), the pretest and posttest scores of the experimental group demonstrated considerable within-group variation.

Table 2. Descriptive statistics of the learning effectiveness of the two groups of students.

| Independent Variable | Group | Pretest | | | Posttest | | |
|--|--------------------|--------------------|------|-------|--------------------|------|-------|
| | | Number of Students | Mean | SD | Number of Students | Mean | SD |
| General teaching method | Control group | 36 | 4.73 | 0.760 | 36 | 5.24 | 0.939 |
| Teaching method using Microsoft Excel computational system | Experimental group | 39 | 5.14 | 0.600 | 39 | 5.52 | 0.816 |
| Total | | 75 | 5.38 | | 75 | 4.94 | 0.896 |

4.2. Analysis of Differences in Learning Effectiveness

4.2.1. Independent-Sample *t*-Test of the Pretest Learning Effectiveness of the Two Groups

After the means of the five subdimensions of the Computational Thinking Scale were calculated, the study used the independent-sample *t*-test to examine whether the experimental and control groups differed significantly in the pretest to determine whether the students had the same baseline learning effectiveness. The *t* value and significance test showed that the test results were not significant. The five subdimensions scores were as follows: menu design and cost planning ($F = 0.519$, $t = -2.098$, $p = 0.473 > 0.05$), food specification computation ($F = 2.534$, $t = -1.573$, $p = 0.116 > 0.05$), computational design and application of catering products ($F = 1.205$, $t = -1.247$, $p = 0.276 > 0.05$), computational thinking and marketing ($F = 3.337$, $t = -1.217$, $p = 0.072 > 0.05$) and catering management skills ($F = 2.592$, $t = -0.873$, $p = 0.112 > 0.05$). The learning effectiveness of the two groups was equal; that is, the students in the experimental and control groups had similar starting points regarding learning effectiveness (Table 3).

4.2.2. Test of the Homogeneity of Regression Coefficients within Groups

To understand whether the scores of the experimental and control groups were statistically significantly different, the study first performed ANCOVA for verification. Before performing ANCOVA, the hypothesis test for the homogeneity of regression coefficients within groups needed to be performed. The main purpose of this test was to verify whether there is a significant interaction between the independent variables and the covariates in the original groups. If the result of the interaction test was not significant, the assumption of

homogeneity of regression coefficients within groups was verified, meaning that ANCOVA could be conducted.

Table 3. Summary of independent-sample *t*-tests for the pretest learning effectiveness of the two groups.

| Dimension | Group | Number of Students | Mean | SD | Mean Standard Error | F Value | <i>t</i> Value | Significance |
|---|--------------------|--------------------|------|-------|---------------------|---------|----------------|--------------|
| Menu design and cost planning | Control group | 36 | 4.86 | 0.980 | 0.163 | 0.519 | −2.098 | 0.473 |
| | Experimental group | 39 | 5.30 | 0.826 | 0.132 | | | |
| Food specification computation | Control group | 36 | 4.76 | 1.025 | 0.171 | 2.534 | −1.573 | 0.116 |
| | Experimental group | 39 | 5.10 | 0.862 | 0.138 | | | |
| Computational design and application of catering products | Control group | 36 | 5.51 | 0.924 | 0.154 | 1.205 | −1.247 | 0.276 |
| | Experimental group | 39 | 5.75 | 0.760 | 0.122 | | | |
| Computational thinking and marketing | Control group | 36 | 5.55 | 0.930 | 0.155 | 3.337 | −1.217 | 0.072 |
| | Experimental group | 39 | 5.78 | 0.711 | 0.114 | | | |
| Catering management skills | Control group | 36 | 5.51 | 0.903 | 0.151 | 2.592 | −0.873 | 0.112 |
| | Experimental group | 39 | 5.68 | 0.739 | 0.118 | | | |

The results of the homogeneity test of regression coefficients within the groups (Table 4) showed that the F value was 1.637 and the *p* value was 0.205 > 0.05, which did not reach statistical significance; this indicates that there was no significant difference in the dispersion of the two groups and that the dispersion conformed to the assumption of homogeneity of variance. Therefore, it was necessary to accept the null hypothesis; that is, the slopes of the two sets of regression lines were the same and the assumption of the homogeneity of regression coefficients within the groups was supported. After the influence of the pretest scores was excluded, the results showed that students’ posttest scores varied significantly according to the different teaching methods. ANCOVA was then conducted.

Table 4. Homogeneity of regression coefficients within the experimental teaching group.

| | | Levene’s Test for Homogeneity of Variance | | <i>t</i> Test to Determine Whether the Means Are Equal | | | | | | |
|---------------|-------------------------|---|--------------|--|--------|---------------------------|--------------------------|-------------|-------------------------|-------------|
| | | F | Significance | <i>t</i> | df | Significance (Two-Tailed) | Difference between Means | SD | 95% Confidence Interval | |
| | | | | | | | | Lower Limit | | Upper Limit |
| Pretest score | With equal variances | 1.637 | 0.205 | −1.805 | 73 | 0.075 | −0.284 | 0.158 | −0.598 | 0.030 |
| | Without equal variances | | | −1.788 | 66.554 | 0.078 | −0.284 | 0.159 | −0.602 | 0.033 |

4.2.3. Univariate ANCOVA

This study took the pretest scores as a covariate and the posttest scores as a dependent variable in an ANCOVA. After the influence of the pretest results was eliminated, the presence of significant differences between the experimental and control groups was investigated. The results presented in Table 5 show that, after the influence of the covariate (pretest scores) on the dependent variable (posttest scores) was excluded, the F value was 49.404 and the *p* value was 0.0000 < 0.05, which means that there were significant posttest differences between the two groups of students. This demonstrates that, after the influence of the pretest results was excluded, the posttest results of the students were significantly different due to the different teaching methods, with a net relevant eta-squared (net η^2) of 0.555. The observational verification power for comparison was lower than 0.8, an issue that could be addressed by increasing the size of the control group. In summary, different teaching methods led to significant differences in the posttest scores of students in the Culinary and Restaurant Management course.

Table 5. Summary of the univariate ANCOVA of the posttest results for the experimental group.

| Source of Variation | III Sum of Squares | df | Mean of Sum of Squares | F | Significance | Net Related Eta-Squared |
|------------------------|-----------------------|----|---------------------------|--------|--------------|----------------------------|
| Experimental group | 34.339 | 2 | 17.169 | 49.404 | 0.000 * | 0.578 |
| Pretest results | 31.179 | 1 | 31.179 | 89.716 | 0.000 * | 0.555 |
| Error | 25.023 | 72 | 0.348 | | | |
| Total | 1889.302 | 75 | | | | |
| Total after correction | 59.362 | 74 | | | | |

* $p < 0.05$.

Table 6 shows that the adjusted mean of the experimental group that received instruction in the use of the Microsoft Excel computational system was 5.006 and the adjusted mean of the control group was 4.868; thus, after the influence of the pretest results was excluded, the average posttest score of the experimental group was higher than that of the control group. In other words, the learning effectiveness of the students who received instruction in the Microsoft Excel computational system was better than that of the students who received general teaching. This result shows that teaching using the Microsoft Excel computational system can improve students' learning effectiveness.

Table 6. Marginal mean after factor (group) adjustment.

| Group | Mean | Standard Error | 95% Confidence Interval | |
|--|-------|----------------|-------------------------|-------------|
| | | | Lower Limit | Upper Limit |
| Control group (general teaching) | 4.868 | 0.099 | 4.670 | 5.066 |
| Experimental group (teaching with the Microsoft Excel computational system) | 5.006 | 0.095 | 4.816 | 5.196 |

4.2.4. Independent-Sample *t*-Test of Posttest Scores for the Two Groups

According to the independent-sample *t*-test results presented in Table 7, after the students in the experimental group received instruction with the Microsoft Excel computational system, their total scores of Computational Thinking Scale were significantly better than those of the control group. The result shows that the Microsoft Excel computational system was conducive to improving the learning effectiveness in the Culinary and Restaurant Management course. Among the five subdimensions, menu design and cost planning showed the greatest improvement, followed by food specification computation, computational thinking and marketing and catering management skills. Computational design and application of catering products showed the least improvement.

Table 7. Group statistics and summary of the independent-sample *t*-test results for the posttest scores of the two groups.

| Facet | Group | N | Mean | SD | Mean Standard Error |
|---|--------------------|----|------|-------|---------------------|
| Menu design and cost planning | Control group | 36 | 4.98 | 1.014 | 0.169 |
| | Experimental group | 39 | 5.51 | 0.955 | 0.153 |
| Food specification computation | Control group | 36 | 5.01 | 1.082 | 0.180 |
| | Experimental group | 39 | 5.27 | 0.946 | 0.151 |
| Computational thinking and marketing | Control group | 36 | 4.49 | 1.028 | 0.171 |
| | Experimental group | 39 | 5.09 | 1.009 | 0.162 |
| Catering management skills | Control group | 36 | 4.74 | 1.203 | 0.201 |
| | Experimental group | 39 | 5.03 | 1.101 | 0.176 |
| Computational design and application of catering products | Control group | 36 | 4.41 | 1.190 | 0.198 |
| | Experimental group | 39 | 4.78 | 1.112 | 0.178 |

5. Discussion

5.1. Learning Effectiveness Is Significantly Better with the Computational Thinking Teaching Method than with Traditional Teaching

The learning method is one of the most crucial factors in students' learning intention and learning style. During higher education teaching, it is critical to cultivate students' ability to analyze and solve problems [51,52]. Higher education represents the highest level of education; consequently, its content should cover not only specialized knowledge that reflects the latest developments in science and technology but also innovation in science and technology to promote the sustainable development of the social economy and culture [53,54]. Therefore, the teaching content of higher education must have a close and coherent practical relationship with social-economic production and real-life science and technology applications. This study combined the concept of computational thinking with a teaching mode that differed from the traditional method used to teach the Culinary and Restaurant Management course. The new teaching mode allows students to coherently combine the Microsoft Excel learning mode with the E-learning platform to process, encode and extract information. Such computational technologies constituted the main learning method for the Culinary and Restaurant Management course and were the prime innovation of this study.

The results of the study confirm that there were significant differences in learning effectiveness between the experimental and control groups. That is, students who received the programmed instruction in digital computation and Microsoft Excel via the school's E-learning platform achieved greater learning effectiveness than students who received traditional general instruction. This verified the findings of many previous studies on computational thinking [55–57]. Therefore, this study demonstrates that curriculum design that includes the concept of computational thinking can significantly improve the overall teaching effectiveness of the course of Culinary and Restaurant Management through E-learning methods.

5.2. Incorporating Computational Thinking into the Catering Course Can Effectively Enhance Students' Learning Effectiveness

This study results show that, in the Culinary and Restaurant Management course, the most significant learning effectiveness occurred for the subdimension of menu design and cost planning, followed by food specification computation, catering management skills, computational design and application of catering products and computational thinking and marketing. This study infers that, in general traditional teaching, the learning and practical aspects of menu design and cost planning and food specification computation are more closely integrated and their technical difficulty makes them challenging for students [58–61]. The integration of the concept of computational thinking and Microsoft Excel computational system can solve the learning difficulties in terms of cost and price fluctuations and varieties of ingredients. Nevertheless, the learning of restaurant operations and management spans multiple dimensions. Students must not only learn the professional culinary skills of the kitchen behind the restaurant, but also learn the marketing, operational and management capabilities of the front-end, i.e., students need to learn and develop comprehensive abilities, including cognition, affection and skills [62,63].

Therefore, integrating the concept of computational thinking and computational programs, such as Microsoft Excel, can facilitate students to improve their learning efficiency regarding the complex cost and many types of ingredients [58,64]. In this study, the students considered the experimental program most supportive for improving learning effectiveness in the subdimension of menu design and cost planning. In addition, the mean score for catering management skills was significantly higher in the experimental group than in the control group, which is consistent with the finding of Donghui [65] and Shen and Zhang [66], i.e., the cultivation of computational thinking not only helps students accelerate their mastery of digital information technology but helps them to improve their

own professional abilities. Computational thinking could be a key business management ability for students in the future.

6. Conclusions and Contributions

6.1. Conclusions

According to the analysis, students in the experimental group believe that teaching using Microsoft Excel via the school's E-learning platform can improve their learning effectiveness and the subdimension menu design and cost planning shows the greatest improvement in learning effectiveness. This study infers the following: (1) restaurant operation includes a process than spans from selecting side dishes to designing menus to presenting finished dishes; therefore, menu design and cost estimation are important factors for operating a restaurant and attracting customers. (2) Both the standardization control of raw materials for food and the precise control of loss rate at every step require digital management; therefore, it is necessary to teach students to review the effectiveness of control and management on a daily basis and formulate a data-based basis of operation. (3) Product design and experience services provided by the restaurant are also factors that attract customers.

In addition, this study finds that excellent learning effectiveness is also achieved for the subdimension of computational thinking and marketing. This study infers that, because restaurants in Taiwan are currently facing challenges due to the coronavirus disease 2019 (COVID-19) pandemic—namely, the government's anti-epidemic policy insists that everyone stay at home and no restaurant dining is allowed—most of the catering industry must strengthen online marketing strategies or join the food delivery E-commerce platform. As the catering industry enters the era of E-commerce, they face an urgent need to strengthen their online marketing. As a result, computational thinking and marketing strategies have become key elements of learning. In a word, this study integrates the concept of computational thinking into the teaching mode for the Culinary and Restaurant Management course through the E-learning platform, achieves the goal of cultivating catering management talents in higher education who align with society's trends in the development of science and technology and concretely manifests learning effectiveness through the teaching theories and learning activities applied of this study. The concept of sustainable education in catering is realized through this process.

6.2. Contributions

Based on a computational thinking-oriented curriculum design, this study conducted a teaching experiment. This study mainly combined the concept of computational thinking with Microsoft Excel computational system and applied them in the Culinary and Restaurant Management course. Besides breaking through the standardized teaching mode of lecturing, more innovatively, this new mode embeds the new teaching philosophy of E-learning that integrates the concept of computational thinking to strengthen the overall performance of students' practical skills in catering management. The greatest contributions of this study are as follows: this new mode stimulates and strengthens students' emphasis on computational thinking and E-learning for improving their practical skills in catering management; this new mode allows students to understand their weaknesses and internalize the computational thinking ability currently required by the industry; additionally, teachers can understand students' learning conditions and use this knowledge to improve their teaching.

6.3. Research Limitations

The study has its limitations. First, the concept of computational thinking and the Microsoft Excel computational system were integrated into only one course. It was not feasible to add more time for more in-depth teaching of the Microsoft Excel software during the established teaching schedule; therefore, it was impossible for the students in the course to learn more in-depth uses of computational thinking. Consequently, the study results are

somewhat restrictive. It is recommended that the current need for computational thinking be taken into consideration for course planning in the future; furthermore, computational thinking and E-learning skills should be integrated into all catering management courses in the future to establish a coherent system for teaching computational thinking and E-learning, thereby cultivating operational capabilities of computational thinking and digital intelligence required by the catering industry.

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