

The Ability of Scratch Teaching in Programming Language— Taking Roguelike Mathematical Games as an Example

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Abstract. In recent years, Japan and Taiwan have begun to include programming education in the elementary and secondary school curriculum as well as in universities so as to strengthen students' programming language ability. In this study, the Scratch programming language was used to design a roguelike mathematical game based on a prince saving a princess in a forest. Mathematics refers to the positioning of each object, its XY coordinates, movement and distance, positive and negative movement angles, waiting time (seconds), and speed. In this study, the mathematical game program was provided to a class of rural elementary school students in southern Taiwan. By imitating the design, the teachers, and students can work together on this hands-on programming project to design the pictures, cooperate in discussing and solving the programming dilemma, and enjoy the game together. The elementary school principals and teachers who participated in the scene observed and concluded that it allowed the pupils to think seriously, enjoy discussing the integration of mathematics and programming, design digital games, and develop the final result of roguelike digital games. This project allowed students to take on the challenge of learning to write programs with curiosity and learn to use different building block programming languages in Scratch to produce a program by imitation. Students can also learn to change and add objects, and arrange the things to be done by different characters through programming. The mathematical roguelike challenges let the students understand the learning achievements through the taste of each victory. Through the game attraction, this study fostered cross-domain digital talents in areas such as digital technology, program education, and artificial intelligence.

Keywords. Scratch design, program education, math, roguelike game, digital roots.

1. Introduction

As information technology permeates life, programs are shaping today's digital world and continue to play a key role in human life. Programming languages have become a new generation of reading and writing abilities [1]. Japan put forward the Future Investment Strategy 2017 [2] in 2017. Since 2020, programming education has been included in the elementary and secondary school curriculum as well as at the university stage, so as to strengthen students' programming language abilities and further improve digital teaching materials and evaluation systems [3]. In addition, talents with digital skills [4] and basic skills such as mathematics, information technology (IT), and information processing [5] will be strengthened in the key project of the Future Investment Strategy 2018. It is important for the cross-domain of digital education to take root in the front-line teaching scene.

2. Research motives and purposes

The inconvenience of logistics and transportation for schools in rural areas affects regional economic development, while the inconvenience of rural living functions and life networks lead to the insufficient supply of resources, resulting in the uneven development of rural areas. It is difficult to nurture talents due to the gap in educational resources, and it is also difficult for rural schools to use or retain teachers in schools in rural areas [6]. The learning motivation of rural students is generally low, and studying in the school system is not the deepest expectation of rural parents for their children. Under a tough environment with a high turnover rate of teachers, instability, and lack of teaching resources, it is difficult for schools to effectively remedy students' backward learning abilities, and it is also harmful to students' right to receive an education [7]. The author has learned from elementary school principals and teachers that rural schools do not have enough teachers who can cope with multiple knowledge and skills in the new era to meet the learning needs of their students. In the long run, students in rural areas may lack a sense of achievement in their schoolwork, and some students will gradually lose their motivation to learn. From the perspective of education, how to regain students' confidence in learning and stimulate their curiosity and desire for knowledge is the key to improving the low motivation of learning, enhancing the sense of achievement in learning, and making rural students become willing to stay in the school system to continue to learn and grow. Therefore, rural schools still need the manpower and technical support of external excellent teachers.

Traditional teaching content focuses on sentences in books and the memorization of abstract ideas and facts with illustration-assisted learning [8]. However, students in rural areas have fewer situations in which the learning content can be combined with life in the process of learning. This study suggested that the stimulation of digital sensory learning by making good use of science and technology to simulate virtual situations and promoting the development of multiple intelligence through providing multiple digital situations to stimulate learning can strengthen the learning content. If the learning attitude of rural children can be improved, it will be more meaningful for the government to inject resources into rural education. How to enhance the curiosity of rural children and develop good learning attitudes? The introduction of mathematics into roguelike games could be an effective solution.

This study solved a number of practical problems through practice. The objective was to deepen and cultivate future interdisciplinary talents through program education combined with mathematics. Through the attraction of games and the integration of mathematics teaching, the changes in the learning attitudes and the influence of the learning achievements of rural students were made, and difficulties that teachers may encounter as well as ways to break through them were found out. Finally, a story game was developed using the Scratch teaching program. Mathematics was integrated into the game to design a mathematical game for teaching so as to help more children in rural areas, give them opportunities to learn math through roguelike digital games, and understand that programs can be used to design interesting and fun digital games, as well as enhance their interest in learning.

3. Literature Review

3.1. Programming teaching to promote a sense of achievement

When appropriate programming tools are provided in the process of solving programming problems to help learners visualize or objectify the problem, learners' thinking and problem solving can be promoted [9]. This study was developed using the Scratch programming language. Scratch was developed by the Lifelong Kindergarten team led by Mitchel Resnick of the Media Lab at the Massachusetts Institute of Technology and was made public for the first time in 2007. It also has a traditional Chinese program interface. Scratch aims to lower the bar for novice users to increase the variety of projects and support different project complexities to plan environment interfaces [10]. In terms of university and elementary school learning, Chinese-speaking students who do not know how to operate the English interface will not face a burden, which increases the interactive convenience of Scratch in teaching. Through Scratch software, students can create their own interactive stories and animated games, and then share their creations online. While learning important computer programming, they also learn to think creatively, reason systematically, and collaborate.

Due to the emergence of visual building block programming languages such as Scratch, Visual, and BASIC, programming is no longer limited to words, which makes it easier for people to understand. Scratch, which has a graphical interface, enables students to experience a sense of achievement through designing games [11]. Programming is an important way to practice the teaching of operational thinking. The act of writing programs can implement the abilities of abstraction, process control, modeling, recursion, repetition, modification, and debugging while focusing on design and creation, and experiencing the process of use can improve personal computing thinking ability.

The Ministry of Education began to incorporate programming into the field of science and technology as a compulsory course in the 12-year national basic education syllabus in 2019 [12]. The purpose was to cultivate students' scientific and technological literacy through the use of scientific and technological tools, materials, and resources, as well as develop their exploration, creative thinking, logical and operational thinking, critical thinking, problem-solving, and other high-level thinking skills. In general programming courses, when teachers use narrative teaching, it is not easy for some students to understand and learn in a short period of time, and if students do not properly complete the programming exercises assigned by the teacher, it will affect the effectiveness of their learning. Programming is not easy to learn. If game elements can be added when learning to program, it can increase learners' learning motivation and effectiveness, and the introduction of competitive strategies can promote the learning atmosphere among learners. Therefore, this study held that if students can be provided with easy-to-use, visible, playable, knowledge-based, and challenge-based case programs in the process of learning by doing, they can be led to learn step by step and quickly acquire programming skills, problem-solving and logical thinking. Through the practical programming process, students can understand how to express and solve practical problems in programming, so as to improve the creative ability of logical thinking and the cultivation of scientific and technological literacy.

3.2. Optimizing the classroom teaching process to stimulate students' interest in learning through play

Yang, Chen, and Chu [13] used digital typing games to teach mathematics in elementary schools, and the students' typing skills and flow experience were better than those using traditional typing software. Weng, Tseng, and Yang [14] enabled students to use board games and card games to design online security teaching through designed game situations, so as to improve students' learning motivation and the learning effect. Therefore, if teachers can use appropriate game learning techniques and integrate instructional designs related to information education, they should be able to help students learn and achieve their teaching goals. The timely injection of games into learning, together with cooperation, guidance, and the provision of performance opportunities can stimulate children's unlimited potential and literacy [15]. Teachers must be able to encourage students to take the initiative to learn and explore while having fun and increasing the desire for knowledge. Education has gradually reversed the concept of education from a one-way thinking learning mode with the lack of a practical school curriculum to the coming of an era in which creative innovation is the main body of competition [16]. If teachers can actively link the quality of introduction with students' curiosity and interest, they can also directly affect their students' enthusiasm in the class. The enhancement of students' curiosity and interest can stimulate their subjective consciousness [17] and open the door to learning, so as to stimulate their own learning initiative and independent thinking ability and achieve better innovative consciousness and innovative ability.

As the main driving force of innovation, interests can better promote learning. Interests arise on the basis of thinking, and the emergence and development of thinking require a certain knowledge base. Attracting students' attention in the process of teaching can enlighten students' cognitive contradictions and complete problem-solving and innovations under the impetus of interest and curiosity. It is well known that students have a strong sense of competition; however, repeated failures in the process of learning will deal a blow to their enthusiasm for learning. In the face of this situation, teachers must provide appropriate cases which have a higher potential for success, so that students can carry out the programming by first imitating them, and feel the joy of success. Therefore, this study assumed that successful cases of designing roguelike digital games should be provided for students' reference. By

learning the basics of designing roguelike digital games, students may place the pictures they like thereon, change the numbers in the games they design and make modifications. When their success rate is improved, their interest in learning can naturally be aroused. In this process, students can give full play to their different strengths, fully display themselves, and find the connection between life and mathematics. They will thus feel the joy of victory and gradually cultivate an interest in innovation.

3.3. Designing programs of roguelike games while learning mathematics

Games can have many applications in teaching [18]. Digital games are attractive to users because they have the following characteristics: (1) they are fun; (2) they are playful; (3) they have rules; (4) they have goals; (5) they are interactive; (6) they have outcomes and feedback; (7) they are adaptive; (8) they are winnable; (9) they contain conflict/competition/challenge/opposition; (10) they focus on problem solving; (11) they allow interaction; and (12) they are based on representation and stories [19]. Digital game learning enables learners to complete educational activities on a computer or through digital products, which allows players to more easily experience the fun of games and creates a broader and more diverse field of vision for knowledge exchange. Digital games also contain interactive features that make learners become players who actively participate in targeted, competitive, exciting, and challenging activities [20]. Chen [21] used English game-based teaching to effectively enhance students' interest in learning and deepen their learning impression through peer discussions in the game process. Matsumoto [22] mentioned that a game-based learning environment can improve learners' comprehension and learning motivation. Menezes and Bortolli [23] suggested that the game process can improve students' problem-solving abilities and enhance knowledge learning. Gamification is an effective way to improve students' learning effectiveness [24]. Therefore, the use of game learning in teaching should help students to improve their learning motivation, interest, problem-solving ability, and learning effectiveness.

It is well known that many games are competitive, which can arouse humans' competitive nature, make the learning process challenging and interesting, and increase students' participation. When mathematical thinking tasks or goals are included in game activities, students need to use their mathematical knowledge to achieve them. By allowing students to use mathematical knowledge or master mathematic skills, the educational goals are achieved. From the educational point of view, the most important feature of a science and technology curriculum that includes mathematical games is to hone students' thinking ability in the application of science and technology.

Practice is not only a means for students to master skills, learn knowledge and develop intelligence but is also the main way to cultivate students' creative consciousness. The main purpose of comprehensive practice is to have an in-depth understanding of knowledge, strengthen specific knowledge connections, and form a better knowledge structure. The main purpose of developmental practice is to cultivate students' innovative consciousness [25]. The purpose of this study was to combine the programming of science and technology courses with mathematics to give students comprehensive practice, on-site practice, and space for cooperation to discuss and solve problems, thus cultivating them to become familiar with the application of knowledge and technology and develop innovative consciousness.

4. Development of roguelike mathematical games

The Scratch programming project included two parts: a media component (media) and a program script (script). Scratch can import picture files and sound files from outside resources, create necessary media components using built-in drawing tools and recording functions, and program scripts designed for the stage, and select 2-D characters (sprites) through color command building blocks [12]. The design concept of Scratch is that designers imagine themselves as a director who must order each role to perform a play on a stage. Each role can be presented with a different shape, and the stage can also have different background presentations. Therefore, the script is based on instructional building blocks that are dragged to the program script area to stack and collage. The whole Scratch code is composed of instructional building blocks and parameter settings.

In this study, Scratch 3.0 was used to design the roguelike game. At the same time, the possible reasons obtained from field interviews with rural teachers were as follows: elementary schools only arrange IT classes to be taught once a week, students have a short time for learning, and students do not understand the process when decomposing the coding steps. Therefore, it takes more time to write program exercises. The number of teachers who can teach coding in rural schools is small, and teachers do not have enough motivation to teach applied coding. Therefore, in the teaching of operational thinking, the key point is to implement the introduction of mathematics teaching, especially in response to the interconnection and integration in STEAM (science, technology, engineering, art, and mathematics) courses. In addition to the learning and application of knowledge, cultivating students' perseverance in problem-solving is also a key point. This study, therefore, adopted the method of combining mathematics development with the design of a roguelike game to enhance the development of the students' mathematics abilities.

During the period of this study in a rural elementary school, the total number of students was less than 70. Thirteen students from one sixth-grade class were taken as the participants. They were asked to refer to a simulation to design an adventure based on rescuing a cat princess in a forest, during which they would encounter a fire-breathing dragon. In this adventure, it was necessary to make good use of mathematical programming to save the cat princess.

The program is described below.

The setting of relevant variables enables the character to act accordingly when the variables change, as shown in Figure 1.

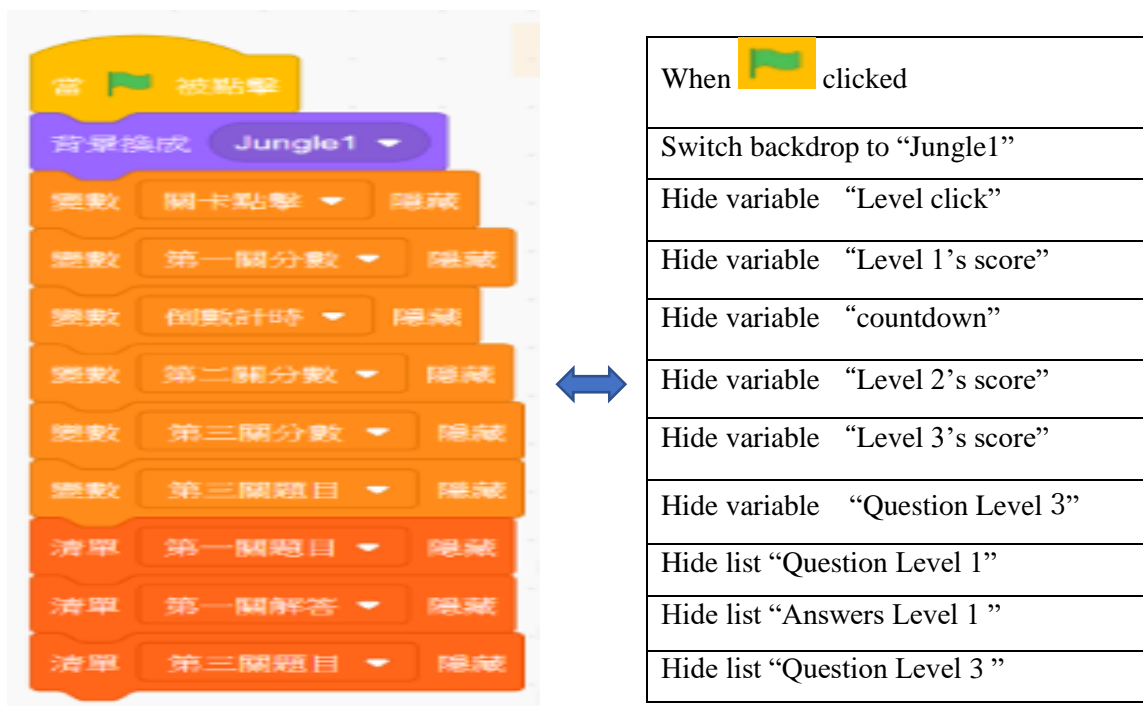
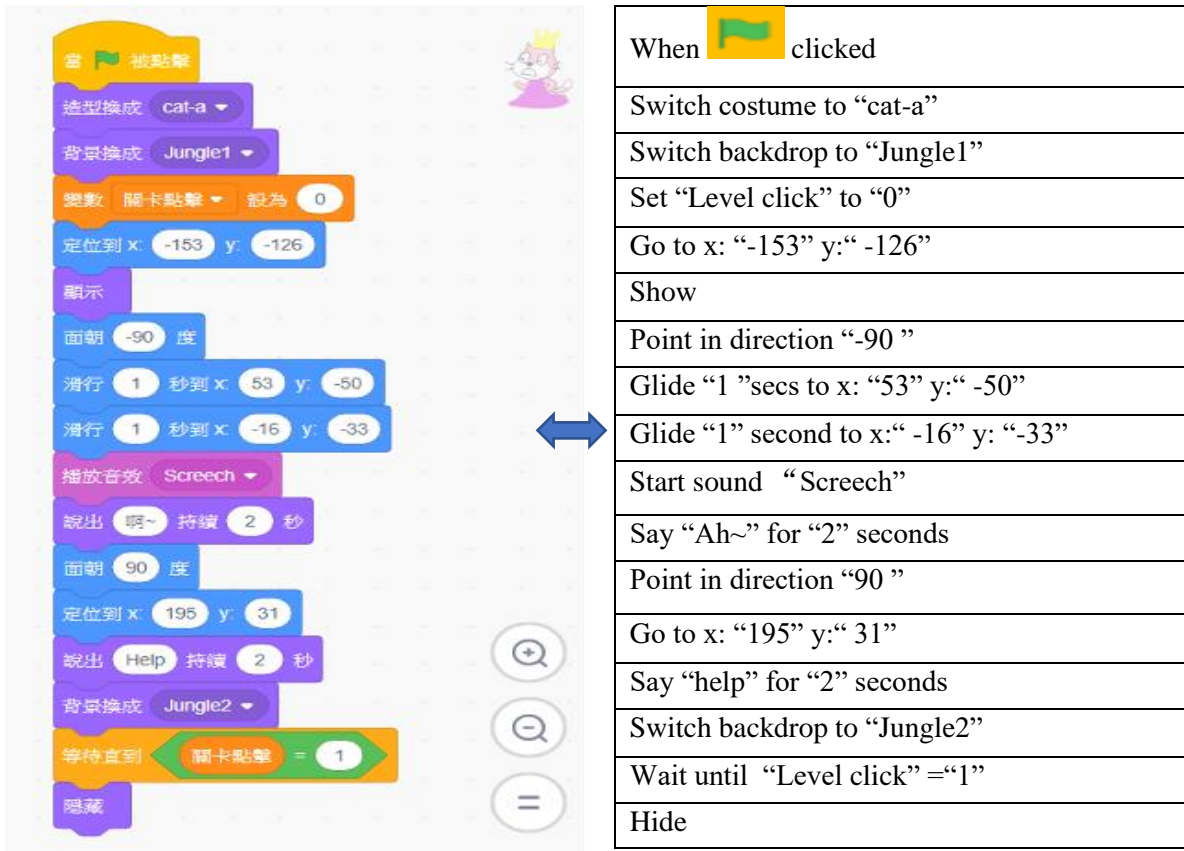


Figure 1. Character actions when relevant variables are set to change.

In Figure 2, the princess moves to the right place and says "ah" when encountering a dinosaur.

The positioning and movement of the XY coordinates of objects (such as the princess and the dinosaur), the angle of the moving objects, and the rationality of time can be used as the best mathematical exercises for students.




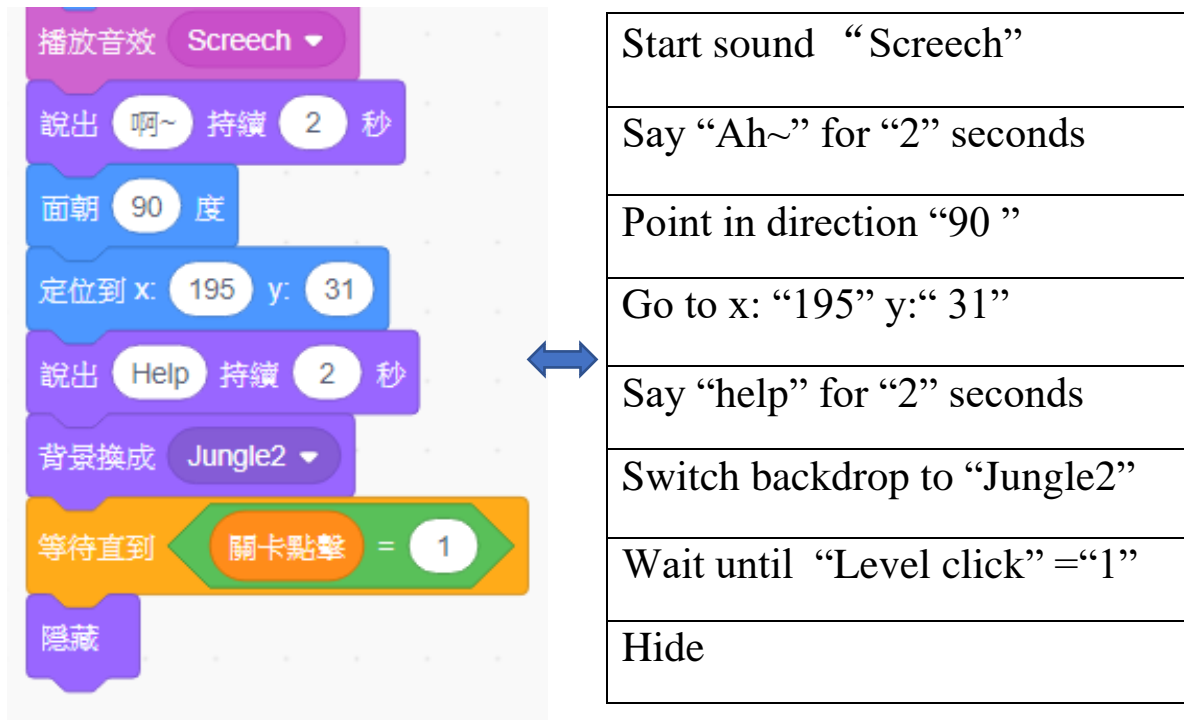
當 被點擊	When  clicked
造型換成 cat-a	Switch costume to "cat-a"
背景換成 Jungle1	Switch backdrop to "Jungle1"
變數 關卡點擊 設為 0	Set "Level click" to "0"
定位到 x: -153 y: -126	Go to x: "-153" y: "-126"
顯示	Show
面朝 -90 度	Point in direction "-90 "
滑行 1 秒到 x: 53 y: -50	Glide "1" secs to x: "53" y: "-50"
滑行 1 秒到 x: -16 y: -33	Glide "1" second to x: "-16" y: "-33"
播放音效 Screech	Start sound "Screech"
說出 Ah~ 持續 2 秒	Say "Ah~" for "2" seconds
面朝 90 度	Point in direction "90 "
定位到 x: 195 y: 31	Go to x: "195" y: "31"
說出 Help 持續 2 秒	Say "help" for "2" seconds
背景換成 Jungle2	Switch backdrop to "Jungle2"
等待直到 關卡點擊 = 1	Wait until "Level click" ="1"
隱藏	Hide



Figure 2. Code for the coordinates, angle, and time of movement of the object, and the control picture.

Figure 3 displays a princess kidnapped by a fire dragon. By moving the coordinates to the side of the dinosaur, the angle of the moving object (face of the princess) is changed.



播放音效 Screech	Start sound "Screech"
說出 啊~ 持續 2 秒	Say "Ah~" for "2" seconds
面朝 90 度	Point in direction "90 "
定位到 x: 195 y: 31	Go to x: "195" y:" 31"
說出 Help 持續 2 秒	Say "help" for "2" seconds
背景換成 Jungle2	Switch backdrop to "Jungle2"
等待直到 關卡點擊 = 1	Wait until "Level click" ="1"
隱藏	Hide



Figure 3. Codes for the coordinates, angles, and time of movement of different objects, and a comparison picture.

Figure 4 shows the prince hiding himself at the beginning. He does not appear until the princess is kidnapped by the fire dragon, at which time he says, "Princess, don't be afraid. I will save you."

When clicked
Hide
When "space" key pressed
Switch backdrop to "Jungle1"
Go to x: "-137" y:" 95"
Show
Say "Don't be afraid, princess. I'm coming!" for "1" sec
Switch backdrop to "Jungle3"

Figure 4. The prince appears and will rescue the princess.


Figure 5 shows the code for the levels and a comparison picture.



When  clicked
Hide

When "a" clicked
Go to x: "119" y:" -132"
Show
Switch backdrop to "Jungle1"
Think "Level 1"



When  clicked
Go to x: "-6" y:" -50"
Hide



When "a" clicked
Show
Think "Level 2"
Wait until "Level click" = "1"
Hide

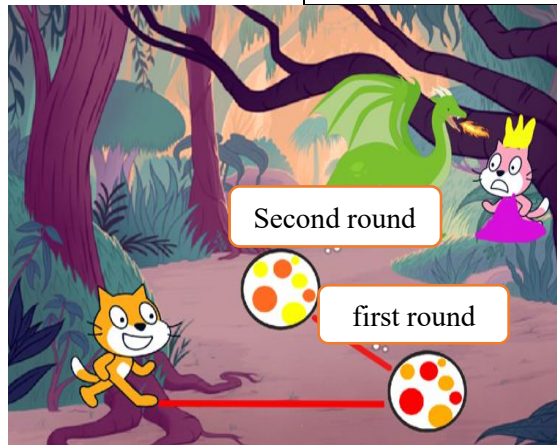
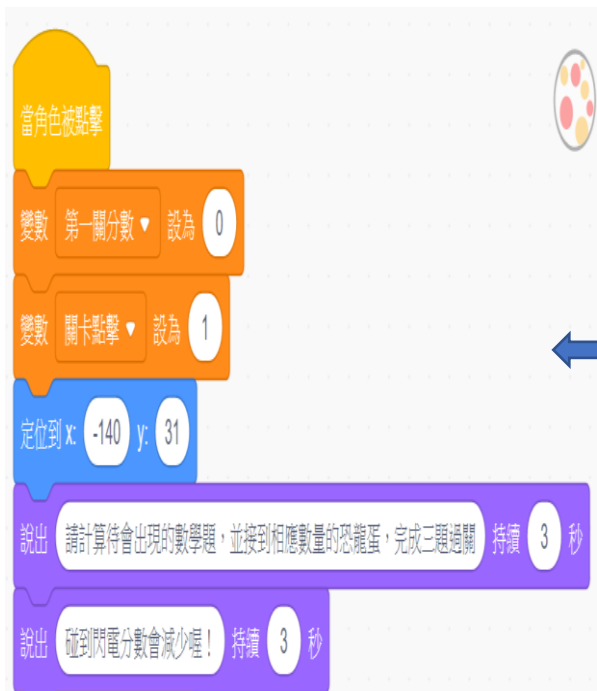


Figure 5. Code for the levels and a comparison picture.

Figure 6 shows the settings of the variables and the level scores. After the dinosaur eggs are selected in the first level, the level click variable becomes one. Other characters can then act and explain the clearance rules through making statements such as: "Please work out the math problems that will appear later to receive the corresponding number of dinosaur eggs. Complete the level by solving three problems"; and "Scores will be reduced when encountering lightning!"



When this sprite clicked
Set "Level 1's score" to "0"
Set "Level click" to "1"
Go to x: "-140" y:" 31"
Say "Please work out the coming math problems and catch the corresponding number of dinosaur eggs. Complete three problems to pass this level." for "3" seconds.
Say "Your scores will be reduced if you are hit by the lightning!" for "3" seconds.

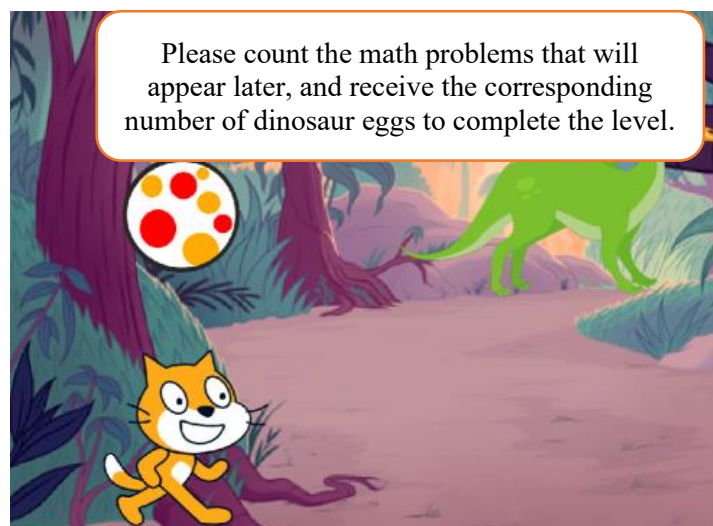
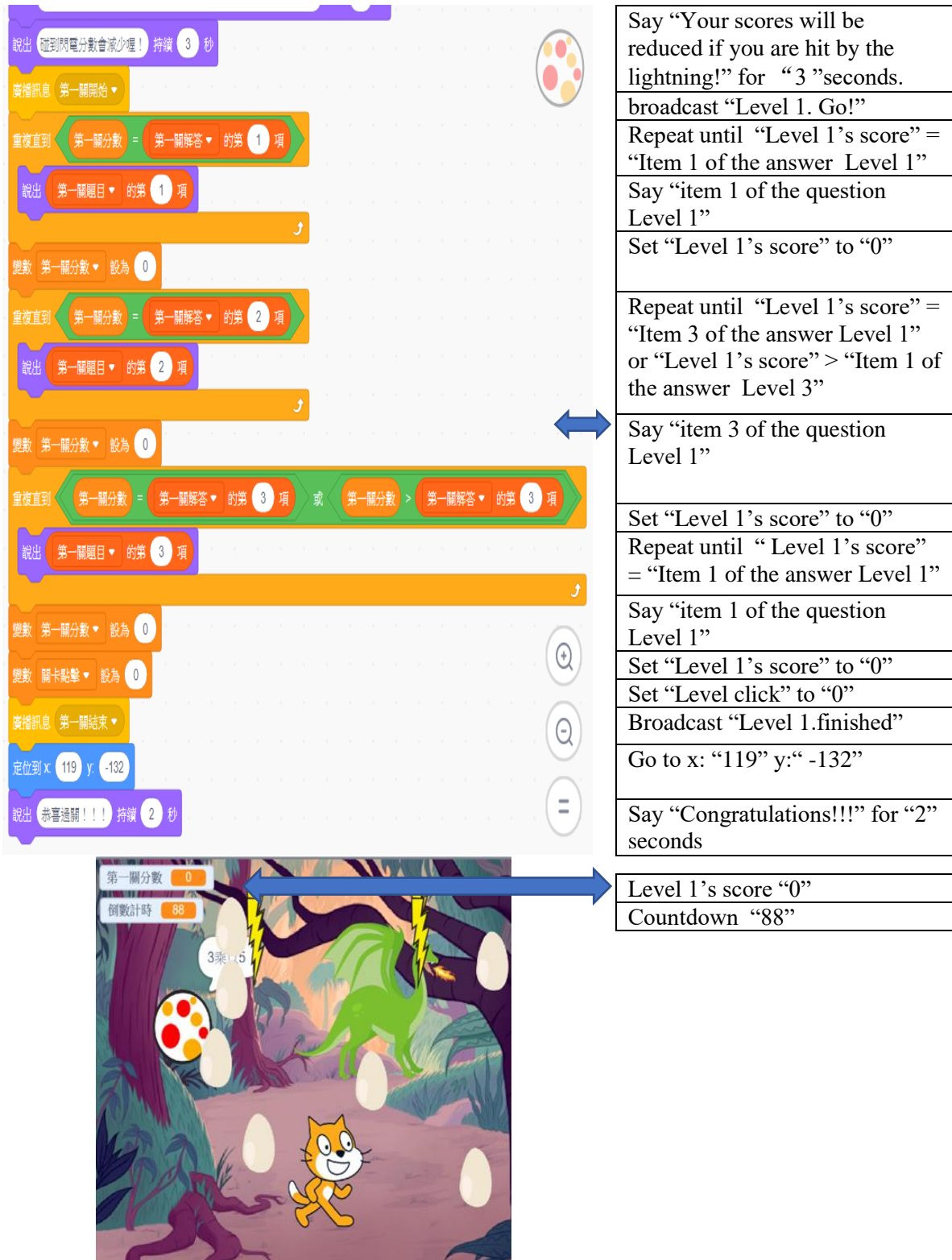


Figure 6. The setting of variables and the score of the level, as well as the text setting of the instructions for beating the levels.

As shown in Figure 7, the dinosaur egg will continue to repeat the question until it is completed. The click variable is changed to zero at the end of the game and broadcast at the end of the first level, at which time a congratulatory message is displayed.



The figure shows a Scratch script on the left and a game screenshot on the right. The script is a sequence of blocks for a level: a 3-second warning message, a 'Level 1 Start' broadcast, a loop for item 1 (score = answer item 1, say item 1, set score to 0), a loop for item 2 (score = answer item 2, say item 2, set score to 0), a loop for item 3 (score = answer item 3 OR score > answer item 3, say item 3, set score to 0), a 'Level 1 Click' variable set to 0, a 'Level 1 Finished' broadcast, a move to x:119, y:-132, and a 2-second 'Congratulations!!!' message. The screenshot shows a forest scene with a cat, a dinosaur, and eggs. A UI panel at the top left shows 'Level 1 Score' at 0 and 'Countdown' at 88. A lightning bolt is shown hitting an egg. A blue arrow points from the 'Level 1 Finished' broadcast block in the script to the 'Level 1 Finished' broadcast block in the table on the right. Another blue arrow points from the 'Congratulations!!!' message block in the script to the 'Say "Congratulations!!!" for "2" seconds' block in the table on the right. A third blue arrow points from the 'Level 1 Click' variable set to 0 block in the script to the 'Set "Level click" to "0"' block in the table on the right.

Say "Your scores will be reduced if you are hit by the lightning!" for "3"seconds.
broadcast "Level 1. Go!"
Repeat until "Level 1's score" = "Item 1 of the answer Level 1"
Say "item 1 of the question Level 1"
Set "Level 1's score" to "0"
Repeat until "Level 1's score" = "Item 3 of the answer Level 1" or "Level 1's score" > "Item 1 of the answer Level 3"
Say "item 3 of the question Level 1"
Set "Level 1's score" to "0"
Repeat until "Level 1's score" = "Item 1 of the answer Level 1"
Say "item 1 of the question Level 1"
Set "Level 1's score" to "0"
Set "Level click" to "0"
Broadcast "Level 1.finished"
Go to x: "119" y:" -132"
Say "Congratulations!!!" for "2" seconds
Level 1's score "0"
Countdown "88"

Figure 7. Setting the number of questions for each level and the corresponding answers.

As shown in Figure 8(a), there is an infinite number of clones, and the dinosaur eggs and lightning continue to generate clones. The waiting time can be adjusted to increase or decrease the degree of difficulty. As shown in Figure 8(b), the if-then function can be used to change the score after an egg or lightning touches the prince. As shown in Figure 8(c), the actions of the eggs and the lightning should be repeated until the end of the first level. This program was designed to allow previous actions to be repeated countless times. After receiving the message of the completion of the first level, all actions of this object can be stopped directly.

(a) Through an infinite number of clones, the dinosaur eggs and lightning continue to generate clones. Adjusting the waiting time can increase or decrease the degree of difficulty.

(c) The actions of the eggs and the lightning should be repeated until the end of the first level. This program is designed to allow previous actions to be repeated countless times. After receiving the broadcast at the end of the first level, all the actions of the object can be stopped directly.

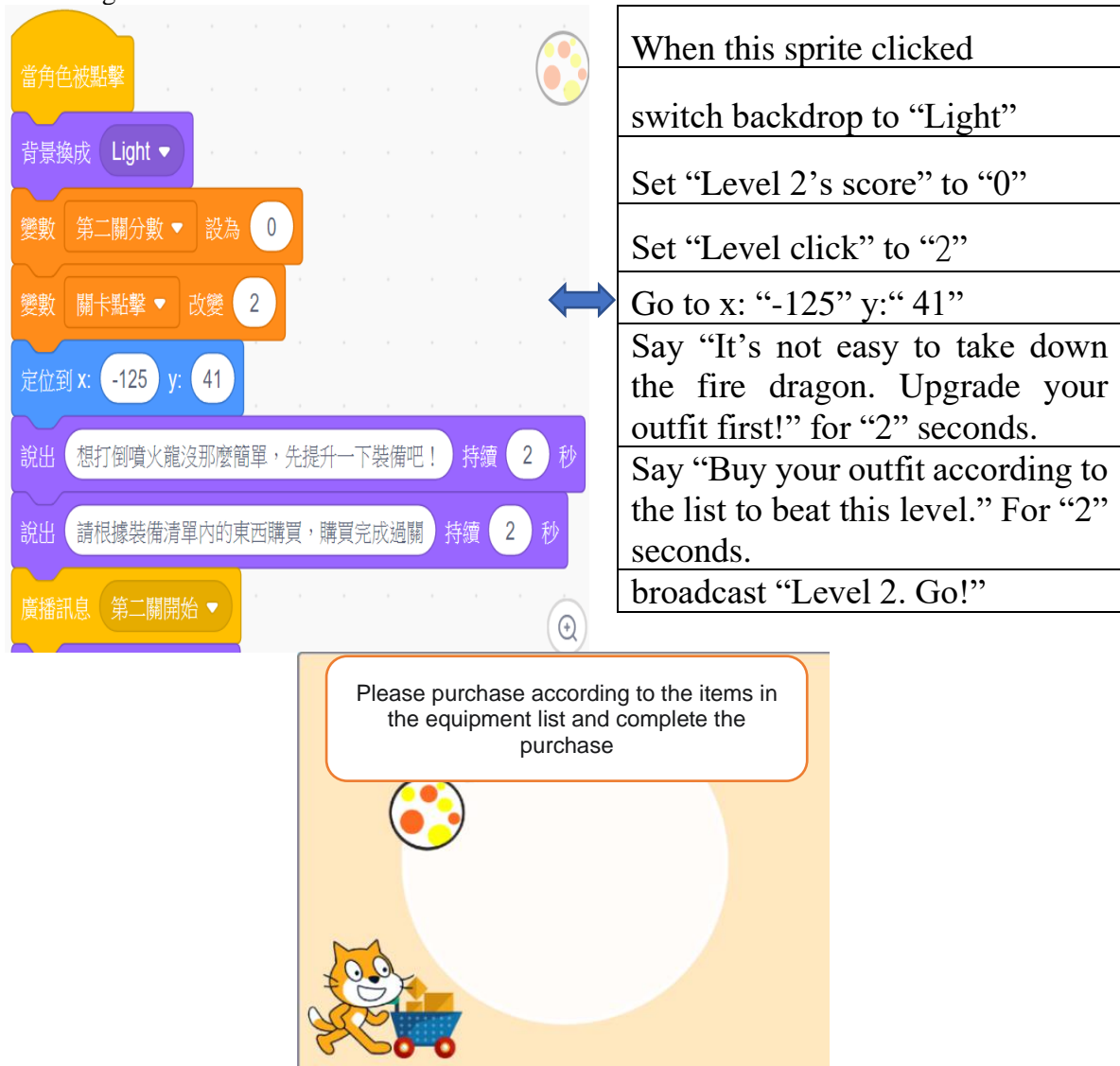
(b) The if-then function can be used to change the score after an egg or lightning touches the prince.

When clicked Hide When I receive "Level 1. Go" Show Forever Go to "front" layer Set x to pick radom "-200" to "215" Set y to "119" Create clone of "my self" Wait "0.5" second	When I receive "Level 1. Finish" Stop other scripts in sprite Hide When I start as a clone Forever Go to "front" layer Change y by "-5" If touching prince then Change "Level 1's score" by "1" Hide If touching "edge" then Go to x: "pick radom -200 to 215" y:" 119"	When I start as a clone Forever Go to "front" layer Change y by "-5" If touching prince then Change "Level 1's score" by "-1" Hide If touching "edge" then Hide
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Figure 8. Program descriptions.

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As shown in Figure 9, after clicking the dinosaur egg in the second level, the background, click variables, and position of the dinosaur egg ball will change. The new rules will then be explained using statements such as: "It is not easy to defeat the fire dragon. Go upgrade the equipment first!"; and "Please make purchases according to the equipment list to accomplish this level." After the rules are described, the starting of the second level will be announced.



The figure shows a Scratch script on the left and a stage view on the right. The script consists of the following blocks:

- When this sprite clicked
- switch backdrop to "Light"
- Set "Level 2's score" to "0"
- Set "Level click" to "2"
- Go to x: "-125" y: "41"
- Say "It's not easy to take down the fire dragon. Upgrade your outfit first!" for "2" seconds.
- Say "Buy your outfit according to the list to beat this level." For "2" seconds.
- broadcast "Level 2. Go!"

The stage view shows a character (Scratch cat) with a shopping cart, and a speech bubble that says: "Please purchase according to the items in the equipment list and complete the purchase".

Figure 9. Purchasing and upgrading the equipment.

Figure 10(d) illustrates carrying out a countdown by waiting for one second. Figure 10(e) shows the need to wait a certain number of seconds to let the character hide.

說出 請根據裝備清單內的東西購買，購買完成

廣播訊息 第二關開始

想著 5 持續 1 秒

想著 4 持續 1 秒

想著 3 持續 1 秒

想著 2 持續 1 秒

想著 1 持續 1 秒

等待直到 第二關分數 = 5

說出 恭喜過關!!! 持續 2 秒

變數 關卡點擊 設為 0

廣播訊息 第二關結束

隱藏

(d) Waiting for one second to count down

Think “5” for “1” second.
Think “4” for “1” second.
Think “3” for “1” second.
Think “2” for “1” second.
Think “1” for “1” second.
Wait until “Level 2’s score = 5”
Say “Congratulations!!!” for “2” seconds.
Set “Level click” to “0”
Broadcast “Level 2.finished”
Hide

當收到訊息 第二關開始

圖層移到 最上 層

顯示

等待 5 秒

隱藏

When I receive “Level 2. go”

Go to “front” layer

Show

Wait “5” secs

Hide

(e) Waiting for a certain number of seconds to let the character hide.

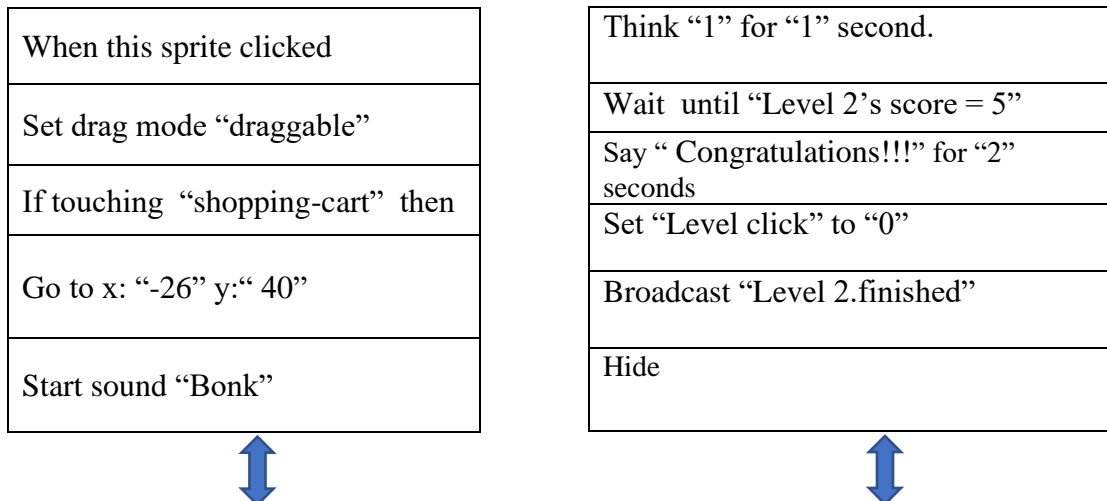
Figure 10 (d) and (e). the programming of the waiting time in seconds for the countdown.

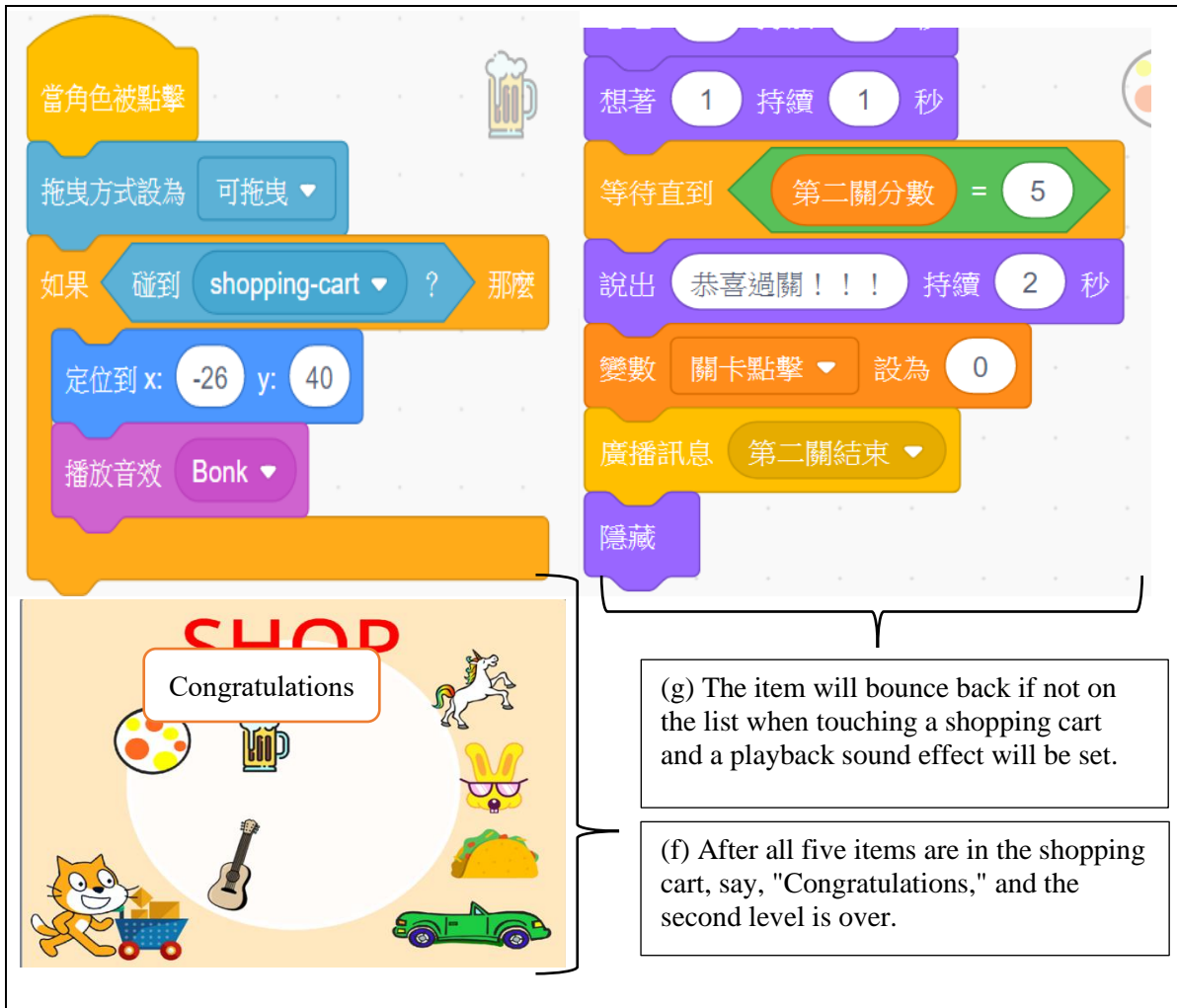
As shown in Figure 11, all options are set to be draggable. Items on the list are hidden if a shopping cart is encountered, and the score increases by one point in level 2.



Figure 11. Options can be draggable, objects are hidden when touching the shopping cart, and points are increased.

As shown in Figure 12(g), the item will bounce back if not on the list when touching a shopping cart, and a playback sound effect will be set. In Figure 12(f), after all five items are in the shopping cart, a congratulatory message is displayed and the second level is over.





(g) The item will bounce back if not on the list when touching a shopping cart and a playback sound effect will be set.

(f) After all five items are in the shopping cart, say, "Congratulations," and the second level is over.

Figure 12. Items (f) and (g) in the shopping cart.

In this study, there were different codes of five-level and two-level games for students to choose from. The following description was used to illustrate breaking through two levels as an example. In Figure 13, the princess is successfully rescued at the end of the game. By moving the object's XY coordinates to the middle, a heart indicating love between the prince and the princess will show up.

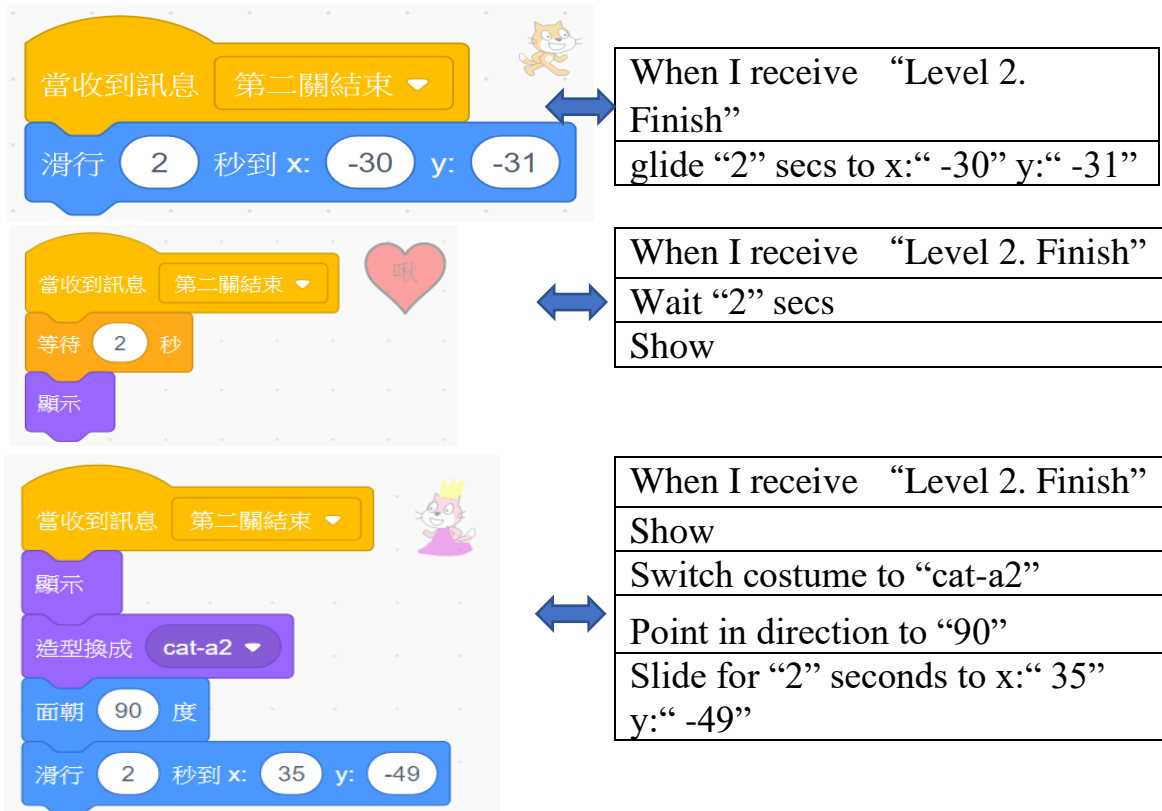


Figure 13. The prince successfully rescues the princess. Move the character and show the heart of love.

The digital game frames could be illustrated by the roguelike game shown in Figures 14(h) to 14(p).



Figure 14. Digital game frames

4.1. The difficulties encountered by elementary school students and the solutions

The difficulties encountered by elementary school students during programming and solutions were as follows. First, there were many objects in the design, and it was easy to neglect some objects when writing the program, resulting in the failure of producing a smooth running game. The solution was for the research team to guide the elementary school students to list and rank the objects and then compare them one by one so as to determine whether they had been used, after which they could be written into the appropriate program one by one.

Next, in the process of physical teaching, it was found that the programming abilities of elementary school students were uneven. Some students were unwilling to learn and even wanted to escape. They were afraid of computer-related courses. It is conceivable that if learning programming requires students to focus on logical structures, it may increase their sense of frustration. This study held that although programming courses are to train programming talents, they should also focus on students' problem-solving processes. Therefore, the purpose of learning programming is not only to understand the instruction statements but also to cultivate the ability to solve problems. Programming includes

understanding problem requirements, writing code, testing, and debugging. Through the programming process, students should clearly understand the actual programming and solve problems. Actual computer operation is an important key for students to achieve learning results in programming teaching. In the process of teaching, it is necessary to emphasize logical thinking and design methods. Students should understand the steps for solving problems, be guided to explore problems, conceive solution steps, write programs and improve their correction and debugging skills when testing a program.

5. Results

Scratch provides an open creative platform containing rich objects, cartoons, colors, instructions, and interactions, all of which naturally inspire students' imagination. Students can create a large amount of content in Scratch. For example, students can use mouse detection and position settings to create animations that follow the mouse cursor. They can also realize more mouse-following functions with the addition of digital and logical operation instructions. Also, the combination of action and sound, detection, and sound can enable students to create different kinds of audio animations. In the course of the implementation of this study, the students (designers) mastered basic producer and director activities, cooperated with others, and took the initiative to explore, discuss, and solve problems and use information technology, all of which echoed the Ministry of Education's goals for information literacy and cultivated the students' scientific and technological literacy abilities.

The method applied in this study was based on holding discussions with the elementary school teachers in advance, designing a case program, trying it out with the teachers several times, and then giving it to the students. As a simple example of a practical game, the prince's task of saving the princess allowed the students to build a sense of achievement. During the teaching process, it was found that sixth grade student A (a female) was passive about learning, shy toward strangers, and not motivated. After learning, she actively wanted to design a program, indicating that student A had the motivation and was interested in game learning; however, the program was still too difficult for student A, who was less able to think about how the program worked, indicating that her prior knowledge may have been insufficient. In spite of this, she remained very interested in this math game. Student A was also listed by the teachers as requiring individual tutoring assistance.

Student B (a male) was also shy and felt strange about what to do before learning, as he had not come into contact with similar math games before. After the learning experience, he was interested and actively discussed the game, sharing the happiness of scoring points with the students next to him and exchanging views. He wanted to take the initiative to continue to try to beat the levels again.

The principal of the elementary school had a discussion on the scene together with the director of academic affairs and a class teacher. They found that as far as mathematics was concerned, the math game brought happiness to suburban pupils to think seriously from games, made them enjoy applying mathematics to design games. During the programming process, the students discussed with each other, solved problems together, and received the satisfaction feeling from producing a smooth running game. Among the 13 students who studied Scratch, 11 students showed a positive learning attitude and strong motivation and interests. Two students were less interested in the program. Most students considered learning Scratch to be interesting and would not cause trouble or anxiety. The results of most education-related studies in Taiwan have also proved that students' problem-solving abilities, geometric concepts, mathematical problem-solving abilities, and scientific problem-solving abilities can be improved after learning Scratch programming courses. For the learners, the result of the program execution was real and closer to their life experiences than that based purely on the use of text output.

As for teachers, they need to understand the difficulties in the teaching of IT courses, and they may encounter the dilemma of needing to solve individual students' program debugging issues. One solution lies in remote network teaching. Through the convenience of the internet, a university teaching team can assist the elementary school when a problem arises and a consensus can be reached through discussions, so as to make up for the time of the elementary school teachers when encountering technical issues during programming education.

6. Research limitations

Due to the long distance needed to travel to remote rural areas, there were only five interactions and two physical teaching activities in the elementary schools during the period of this study.

7. Conclusion and suggestions

7.1. Conclusion

The introduction of Scratch into the elementary school classroom was loved by the pupils and accepted by the teachers. Through the practice of mobile information education, both the elementary school teachers and the researcher found that it could effectively stimulate the students' interest in applying the mathematics learned in class to programming, exercise their logical thinking abilities, cultivate their own innovative spirit and practical abilities, and try to create their own game results. Through programming, the students were able to master new technology more skillfully, not only to interact with the new technology but also to use it to express themselves, express ideas, and create easily.

The development of digital technology, artificial intelligence, and other technologies will greatly replace the existing labor force, accelerate the change and evolution of industry and lifestyle, cause new industries to emerge, and release more job opportunities. Countries have endeavored to cultivate cross-domain digital talents, which are the key to affecting national competitiveness. When the researcher entered the classes in the rural elementary schools to teach, it shared program languages along with the game and aroused the curiosity of the students. The imitation-based learning, cooperation, and discussion aided the students in solving game design problems, and the hands-on project was carried out through digital learning. Through combining mathematics with program education, the digital technology human resources were able to take root and develop.

People who have played games know that there is a kind of magic in the game world that makes players unable to extricate themselves. Those who like to play games often want to design their own games. This study presented an easy-to-understand and interesting game in which the prince saves the princess and the players win the game. The students use mathematics to design their own roguelike games. Through the game, the students were guided to participate actively instead of listening passively, causing their spontaneous learning. Specific operations and exercise experiences can help prepare students for the learning content and establish basic writing program skills, and mathematical concepts and skills. This method of combining mathematics learning with programming education through designing a roguelike game can cultivate a correct mathematical attitude and stimulate students' interest and motivation. It can help students process what they learn in school, help them become proficient in basic computing methods, and allow the flexible use of computing power. It can also provide students with successful experiences and help them build self-confidence.

It is suitable to combine mathematics teaching activities with science and technology courses, train students to do practical work, and transform the mathematics knowledge into the design of game activities. The mathematics knowledge can be presented in a planned way in the form of games and game activities, which can allow students to actively participate and acquire conceptual knowledge to improve their learning effect and interest.

7.2. Suggestions

University social responsibility was implemented through teaching in rural elementary schools, and universities should act as a support system for rural schools. It is suggested that a long-term and sustainable cooperative relationship should be established between universities and rural schools. Universities should show their professional support function and act as a bridge between rural schools and communities so that schools and communities can work together to achieve unity, mutual assistance, and resource sharing, so as to provide more diversified learning opportunities that are conducive to the incubation of literacy in rural children.

It is suggested that a case study be conducted for underperforming children in order to understand which elements of the rural digital artificial intelligence program and the integrated education of various disciplines are most helpful to rural children.

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