

# 行政院國家科學委員會專題研究計畫 成果報告

## 炸彈超人遊戲式教學與合作學習系統-以 C 語言教學為例 研究成果報告(精簡版)

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 期中進度報告

炸彈超人遊戲式教學與合作學習系統-以 C 語言教學為例

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# Game-based Digital Learning System Assists and Motivates C Programming Language Learners

## 中文摘要

程式語言初學者需要互動式學習環境，顯示視覺化執行結果、編譯程式與程式除錯。學習者能夠一邊練習，一邊挑戰自己在程式語言上的學習，這樣的遊戲式學習方式可以提高學習動機與興趣。本計劃提出的遊戲式學習結合作學習的學習環境，可以運用在正規或非正規的程式語言學習與教學。學習者可以透過系統觀看學習教材、讀/寫 C 程式語言，解決 C 程式語言並且控制遊戲中的炸彈起人的角色移動。除此之外，支援合作是學習的語音溝通，從團體合作學習中發現與解決問題，增加學習互動與學習動機。

## Abstract.

Programming language beginners need interactive learning environment, show the visual executing result, compile and debug information. Learners can practice and challenge themselves in an interactive game which is full of entertaining. The proposed game-based learning environment designed most concepts in introductory C programming language and could be used in formal teaching/learning process. Learners can view the learning materials, reading/writing C codes, solving problems with C codes to control the movement of the Bomberman. Besides the user can use the server / client tool embedded voice and text chat communication to support collaborative learning via internet. Learner can study from group's collaborative learning, find and solve the problem of C programming language designing through communicating and discussing.

## Keywords

C Programming Language, Game-based Learning, Collaborative Learning

### I. Introduction

The game always make interesting for people. So we want to integrate games into the learning environment. Game-based digital learning (GBL) assists teachers change their teaching functions. It provides a fun and lives up learning environment. In GBL, students have some tasks that can challenge themselves. After each task they can get encouragement. This is the most important motivation for students. Maybe the Game-based digital learning has much advantage, but it also has the weakness. For example, instructor must know the teaching materials surely. They should in according to these materials to design the game and need to adapt the leaner. In the digital learning environment, it also has many technologies help designer like the multimedia. The multimedia attract learners' attention, it focus their mind on the learning behavior.

Computer games have become an integral part of the popular culture in modern societies. Moreover, "game-based programming" is the latest buzz word in

the computer science educational curriculum. Research [1] shows that students today have a totally different way of learning – react more to interactive learning. If they are not entertained while they learn, the instructor has lost them. However, much of content that needs to be learned by students today lacks of motivation to them. The word "boring", "dry" and "too technical" often crosses their lips [2]. Finally, it leads to frustration. A good game helps students to enhance their learning techniques, such as learning by doing, learning from mistakes, goal-oriented learning, discovery learning, task-based learning, question-led learning, and etc [3]. Although game-based learning has been made a good progress in academic research [4, 5, 6], using computer games for educational purposes has been rather uncommon. Although learning by playing has been reported to education (Roussou, 2004), nevertheless, it is still less popular in post-elementary education.

C programming language is a procedural programming languages, it was spread to develop many system software. Therefore C programming is very important basic language to learn programming. We think a function to modify the learning behavior. Using game-based learning develop a system that assist students in learning activities. In this paper a new approach to the student activities that supplements the ordinary auditorium lectures is proposed. We apply a computer game, called Bomberman, to develop a C programming language course. Bomberman is a strategic maze-based computer game originally developed by Hudson Soft [7].

Collaborative learning has offered a chance to learners working together to reach a common goal. And collaborative learning uses a way of group-learning, with classmates learning together to increase their own and other classmates' awareness [8, 9]. Learners' co-operation and teamwork always support collaborative learning. Through enhancing information sharing and supporting the group process, effective collaborative learning might be reached. Improving the learner's participation and ameliorating join actively in knowledge construction by assisting creation, exchange, and analysis of information during learning group interactions, it will be made possible to increase the effectiveness of collaborative learning [10, 11 and 12]. During the collaborative learning process, all teammates will benefit from each other [13]. The approach to education that is more suitable to the educational environment through group collaborative learning. In this paper, we introduce the system architecture which we have developed, that include audio and text information communication to support co-operation and teamwork, and it has program co-editor interface [14].

The rest of this paper is organized as follows: Section 2 presents related work about our research. Section 3 introduces the main research of the system architecture implementation. Section 4 concludes this paper and discusses the future works.

### II. Related works

In this section, we are going to introduce the related work about this paper. First, we will present the theoretical background about collaborative learning.

Collaboration defined "working together to complete the shared goals" [15]. Collaborative learning allows students to share their knowledge and information each other within the problem-solving process [16]. Second, we present the ways of teaching / learning C programming language. Third, we introduce some Visualization and multimedia supported Programming Language Learning Tools. At last, we will talk about the theoretical foundations of VoIP, the technology we use in our system.

#### A. Collaborative learning

Studies have shown that collaborative learning procedures have proved to be more effective than traditional instructional methods for student's learning and academic achievement process. It also improves participants' satisfaction with the learning [11, 18]. Learning is sharing, and more shared that is more learned. It is even supposed that students are learning as much from each other as from teaching material of course or from the teacher in the class. In America, the studies have also presented that students who usually use the collaborative learning procedures in class, they have more interaction with each other, and they are more satisfied with their learning experiences. Besides, group-oriented collaborative learning, reflection and connection enhance learning.

Collaborative activities are one way of learning by allowing individuals to exercise, verify and improve their mentality through questioning, discussing and sharing information during the problem-solving process [11]. And then, collaborative learning has an obvious potential to improve critical thinking, creative thinking, elaborative thinking, social communication, and social skills (leadership, decision-making, trust-building, conflict-management, etc) [13, 19].

#### B. Teach / Learn C programming Language

C programming Language is a general-purpose, structured, procedural and imperative computer high-level programming language. It developed in 1972 by Dennis Ritchie at the Bell Telephone Laboratories for use with the Unix operating system. Although C was exploited in last three decades, it is also one of the most important and popular programming language at this time [8]. In practice, Students need to know how to [20]:

- a. Discover and understand the problem
- b. Work toward a solution
- c. Rework the solution into code
- d. Enter the code into the computer
- e. Debug syntax errors
- f. Test and debug logic errors
- g. Verify that the problem has been solved

Through these seven steps, students can learn logical thinking and how to solve the problem of C programming language. Besides these steps, students have to learn the syntax and structures of C programming language. Finally, students will accomplish more tasks and improve problem-solving skills when they master these steps.

#### C. Visualization and multimedia supported Programming Language Learning Tool

Visualization and multimedia supported software

makes people learn abstract concept more easily. Mulholland [24] concluded that software visualization has to provide proper assistant for the users when they try to learn and understand the computer programs. Users can understand easily by mapping the abstract program code and the visualization presentation. With the visualization of some specific points, users are able to test and predict the result of the executing program code. Digiano et al. [22] proposed and integrated some learning support in designing a visual programming system which is emphasized on annotatability, scriptability, monitorability, supplementability and constrainability. The five design characteristics of visual programming system addresses the educational needs of the learners. Ángel et al. [23] propose the automatic generation of visualizations and animations for programs. Students can write their program with a user-friendly system supporting generate program animations. For the teaching need, Angel et al. are devoting to develop and maintain animations. Considering friendly and useful support, such as providing simple installation packages or certain educational instructions will be beneficial to learning and teaching. Christopher and Jonathan [24] created the pedagogical algorithm visualization (AV) system which produced graphical representations to help students understand the dynamic behavior of computer algorithms. They invented the possibility of "What You See Is What You Code". In this system, each line of algorithm code is edited and reevaluated every edit. The system displayed immediate feedback along with immediate code editing.

### III. System Architecture

In order to develop a convenient and effective architecture, we use web based server-client architecture. In System architecture, learners can employ the learning and teaching tool from client. Server will save learner's learning record after they complete the test. Learners also can look for the learning progress from the web server. For the teachers, they can understand students' learning situation in the test and to assist learners some necessary learning behavior.

From the opinion of Din W. H. (2006), a successful education game has the following five main factors:

- (1)The game itself must be immersive.
- (2)The playability of the game must be elevated.
- (3)The game must be attractive, challenging, and competitive.
- (4)The game should offer a goal or several goals for players to achieve.
- (5)The game should allow players to track and manage their progress.

Followed the aforementioned characteristics and successful factors, we introduce the seven components as follows.

#### A. Road map

In order to have an overview to students, it has the "road map" function. In a sample way, it likes the catalogue to a book. So we can define it is the teaching plan from course designer. In Figure 1, the area "1" is the road map option of system. The area "2" means the history records that represent the user have pass the test.

The area “3” is our main role bomberman. The area “4” is the barrier means the unit in the C programming language course.

### B. Presentation

User can select second option “presentation”, the area “1” in Figure 2. In this function, we integrate open source Jxpose (Juanola and Lemme, 2004) to design, it is a presentation making software. Jxpose likes the “Microsoft PowerPoint” in java. Number two can choose each of the pages in our teaching material. Number three function can use the full screen and load other chapter.

### C. Example

There are two components of this function in the area “1” in Figure 3. The first component is the “Code reading”. We provide the rule explain in the area “2”. It explains the task of the example one. Let the user to understand the course correctly. In the area “3”, it will display the code to user. Another component of the example is “Run” (Figure 4). This interface can enrich the teaching contents and engage the learners. We use the graph to represent the number of array. It shows likely the area “1” and “2”. “1” is the original graph and user must to modify the code to become the “2” area. The area “3” can select the other example. Number four will compile the enter code. If the logic is no error, it will show the frame. But not surely the correct frame.

### D. Exercise

Exercise also has two components. The different between the example and exercise sub-component is the area “2”, “3” and “4” (Figure 5). In area “1” has some suggestion to learner. In area “2”, we don’t provide the code to learner. They must to write the code themselves. In exercise have a new toolbar. Number three and four can load file and save code. Number four can compile the code which the learner written. We can increase the difficulty to learner. For example, here are two kinds of fruit. After learner finish the code, they can click the area “3” to submit the code and “4” to compile the code. And the frame must to appear the same of the area “1”.

### E. Test

Most of the test functions are similar to example and exercise (Figure 6). But it is the most difficult to these three components. The result that learner must to finish show in the area “1”. Test component also can test learners’ learning situation after the look for example and practice exercise. When they finished test1, they can enter the example2. We provide a step by step learning environment.

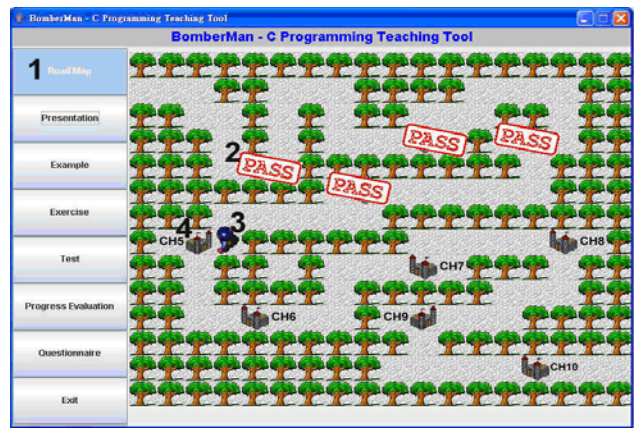


Figure 1: Road map

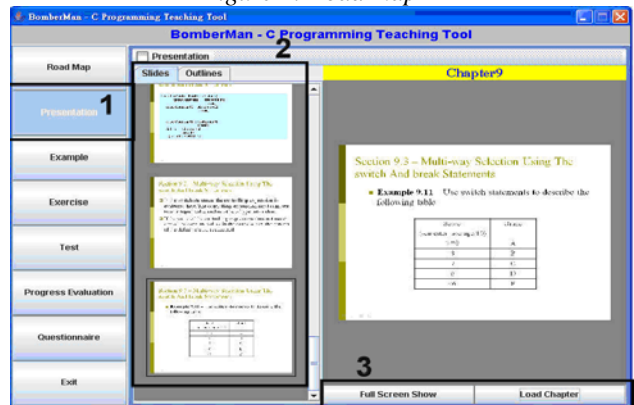


Figure 2: Presentation



Figure 3: The “Code-Reading” sub-component of example

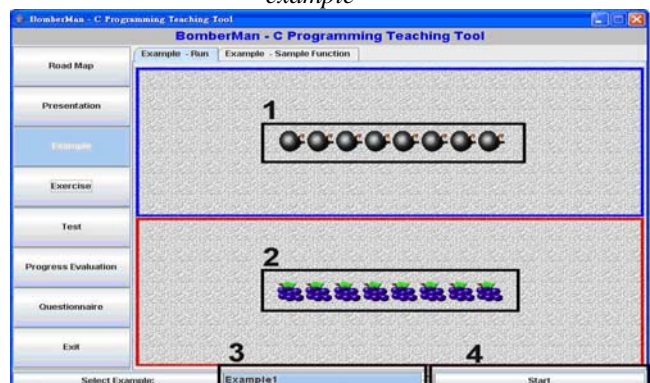


Figure 4: The “Run” sub-component of example

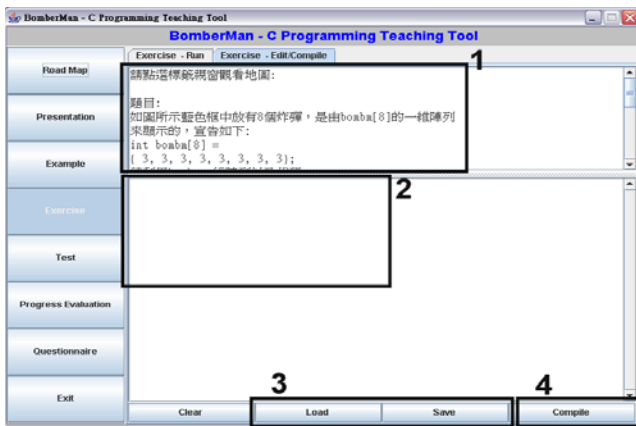


Figure 5: The “Code-Reading” sub-component of exercise

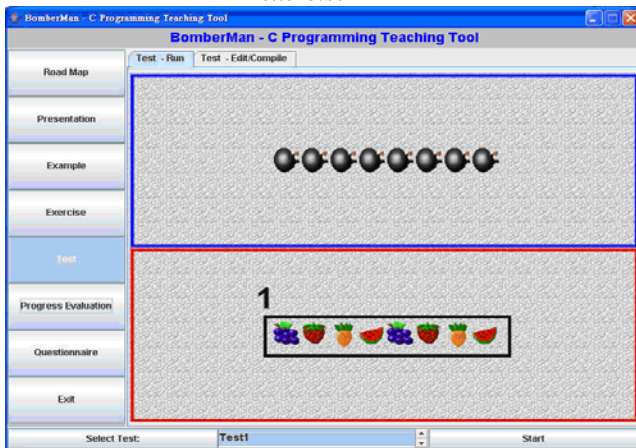


Figure 6: The “Run” sub-component of test

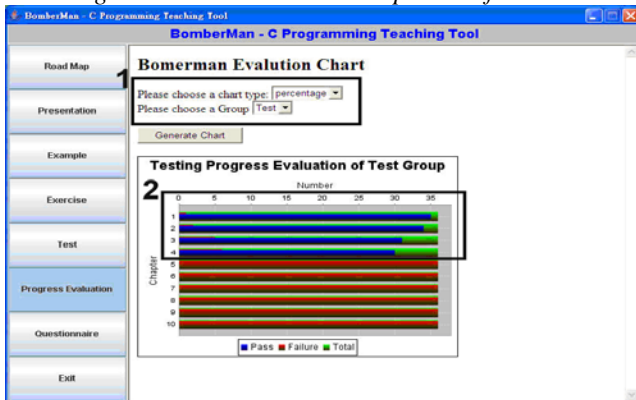


Figure 7: Progress Evaluation

#### F. Progress Evaluation

Figure 7 shows the progress evaluation which collects information from learners who can view it by themselves. The area “1” can select the chart type to show in frame and select the group which users want to know, here are two groups about the example and test. A sample progress report of a student shows in the area “2”. The report means the number of trials ranking of the tester.

#### G. Course design

The system shows an example in the upper area first, and then learners try to modify or write the code to run the lower area result exactly. There are four courses we developed in bomberman game. First course is one dimension array. Second course is two dimension arrays. Third is if-else statement. Fourth is the Switch Case statement.

There are eight bombs which can be represented in C language in the upper area. One dimension array

“bombm” has eight integer elements which has C language form “int bombm[8] = { 3, 3, 3, 3, 3, 3, 3, 3};”. Each number represents one kind of fruit. 3 is bomb; 23 is grape; 24 is strawberry; 25 is carrot; 26 is watermelon.

Programming area supports learners to practice various kinds of correct code. Learners have to solve the problem with C codes by presenting four strawberries and four carrots. Learners can solve the question by four codes in the following. The second course is similar to the one dimension array.

The third mission for learners is using “if-else” statement to complete the code which assists bomberman to walk to the lower right exit. The “FLOOR” means bomberman can pass without obstacle. There are four direction variables, RIGHT, LEFT, UP and DOWN. When the direction is RIGHT, the bomberman will go right. All the map is consisted of maze[i][j] which is a two dimension array. Therefore, maze[i][j+1] represents right position, maze[i+1][j] shows the down position. There are two correct answers for “if-else” test.

The fourth mission for learners is using “switch-case” statement to complete the code which assists bomberman sums the fruit score when crossing the fruit. Each kind of fruit has different score, grape 500, strawberry 300, carrot 200 and watermelon 100. Each figure has an individual number, Bomb (3), Grape (23), Strawberry (24), Carrot (25) and Watermelon (26). The sum of each fruit score is named as grape\_price, carrot\_price, strawberry\_price and watermelon\_price.

#### H. Cooperative Learning Tool

Considering the collaborative learning efficiency, we designed three users a team which includes one team leader and two partners to use our tool. Master server mainly controls the learner information, such as learner portfolio and information transmission. We list the functions as follows:

- User Login/Logout: When user login the system which will record the IP address and learner information. After the user logout, the system will close the editing window and terminate the connection.
- Login User: We designed three people in a study group which is consisted of group leader and two group members. Because the main purpose of our system is to assist the group's work and cooperate together, to finish their homework and task.
- Record and Communicate the Message in the Chat Room: Users can discuss how to program or what kind of function should be used in the chat room. Master server will broadcast the instant message and record the message in a text file which will be stored in system record file permanently.
- Dispatch the Program Editor Sequence Automatically: Master server dispatches the users with login order, the user has his/her own editing interface.
- User Synchronous Programming: User can edit the program in each editing window; the user program will be broadcasted to the team member after a period of time.

- Record the User Program Progress Automatically: The system will record user's program progress automatically in a period of time, in case that the users disconnect abnormally to lose the information.
- Connecting to Voice Server: Connecting and recording the voice server IP address to support voice communication service simultaneously.

A voice server supplies user communicates with voice and records the discussion. Voice server applied VoIP (Voice over IP) technique to connect all the users in real time. Voice communication is divided into group talk and private talk. Group talk furnishes users voice talk with other team members. Private talk supplies one to one discussion to solve the program writing problem.

- Program Editor: The upper side has three columns for three users to edit the program. The left window is designed for team leader, the other two windows for the team members. The system will distribute the user interface automatically. In Figure 8, team leader can arrange the sub-tasks for the other two teammates. For program writing, there will be one main program and other functions. Team leader handles the main program, the other two teammates focus on functions writing. The system will record user's program progress automatically in a period of time, in case that the users disconnect abnormally to lose the information. During the process of program writing, the user can't edit other members' editor besides his own editor.
- Chat Room: Chat room plays a role to supply a text typing mode for uses who like to copy the code and communicate the programming problems. In programming course, some users have problems using the commands and variables. Some problems are suitable for text mode and some are proper to talk with voice directly. The similar situations occur in MSN communication in our daily life. Sometimes, people just like talk or type text when discussion. Therefore, we provide voice and text tools for communication.
- Debug Message Window: Debug message window shows the error message when users click the compile button in the toolbar. Leader or other partners can give suggestions to each other for correcting program error.
- Voice connecting status window: When users use [Voice Dialog], the tool launches a voice connecting status window which shows the connection status.

Users can program cooperatively with the other two teammates or learn how to write a simple program by imitating other codes. All the team has to write the program. Team leader is responsible of main program. The second user is in charge of `user_request()` and `print_menu()`. Third user writes `draw_triangle()` and `draw_rectangle()`. They can discuss and teach each other. The partners can imitate and learn how to code C programs.

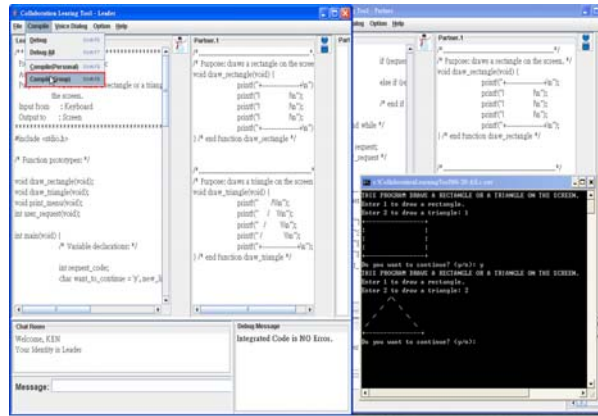


Figure 8. Editing program with teammates and support compiling and executing the program

#### IV. Conclusion and Future Works

In this paper, we develop a tool to support group collaborative learning, which combines voice and text communication mode to assist with the teamwork more effective. Learners will learn more problem-solving skills and more knowledge of C programming language when they interact with other users using our application. Through real time discussion and information sharing, users are going to complete their homework and project more and more.

We compare the proposed system to most traditional tools and Scratch tool. The proposed system provides high interactivity and amusement than traditional tools. Scratch tool supports high interactivity, amusement and easy to use. But scratch tool is not designed for college students to study formal programming languages.

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## 目前已發表之國科會研究成果

### 期刊論文

稿件投稿→ Computer Support for Peer Tutoring and Learning in C Programming(審稿中)  
(ACM Transactions on Intelligent Systems and Technology)

稿件投稿→ Board Game Supporting Learning Prim's Algorithm and Dijkstra's Algorithm  
(The International Journal of Multimedia Data Engineering and Management(IJMDEM) (已接受)

### 國際研討會論文

- [1] Wen-Chih Chang, [Yu-Min Chou](#), [Kuen-Chi Chen](#): Game-based digital learning system assists and motivates C programming language learners. [NCM 2010](#): 704-709
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- [3] Wen-Chih Chang, [Kuen-Chi Chen](#): Collaborative Learning Tool Applying to C Programming Language. [ICWL 2008](#): 178-186

# 行政院國家科學委員會補助國內專家學者出席國際學術會議報告

99年 8月 23日

附件三

報告人姓名	張文智	服務機構 及職稱	中華大學資訊管理系 助理教授
時間 會議 地點	99年8月16日- 99年8月18日	本會核定 補助文號	NSC 98-2511-S-216-002
會議 名稱	(中文)第六屆網路運算與進階資訊管理國際研討會 (英文) NCM2010: 6th International Conference on Networked Computing and Advanced Information Management		
發表 論文 題目	(中文) 遊戲式數位學習系統支援 C 語言學習 (英文) Game-based Digital Learning System Assists and Motivates C Programming Language Learners		
報告內容應包括下列各項： <p>一、參加會議經過</p> <p>第一天的議程，因為班機於晚間抵達，因此無法如期參與。 第二天的議程，參加報告，並且於報告中，會議主席 chair 提出建議，在論文研究中加入驗證分析，深入探討的結果，對於論文貢獻較佳。</p> <p>在會議進行中，我們本次籌辦大會的主席 Franz Ko, Ph. D，並且一同邀約明年將在台北舉辦國際研討會。透過 Franz Ko, Ph. D 的介紹，我們也認識了本次 keynote 演講學者 Jungpil Shin 博士，來自於日本 AIZU 大學，並且彼此交換研究心得與分享研究主題。</p> <p>二、與會心得</p> <p>在參與會議過程中，學者們因為有不同的學術領域與專業，因此開放的在討論中彼此交換意見與心得。</p> <p>例如，詢問了報告者關於 wordnet 運用的實際範例如何運作。 論文名稱 An Automated Semantic Annotation based-on Wordnet Ontology，作者 Che-Yu Yang</p> <p>例如，詢問了報告者關於 Handover 在研究理論中的模擬如何進行。 An Intelligent Handover Decision Mechanism for Heterogeneous Wireless Networks，作者 Shih Jung Wu</p> <p>例如，提出行動醫療在目前台北市政府的建置與政策，提出建議。 A Personalized Healthcare Service on Aged Stoke-Precaution 作者 Yuan-Chu Hwang</p> <p>透過國際會議更了解國內外對於資訊管理領域與資訊技術領域多元的應用，對於也是需要跨領域合作的遠距教學是一種很棒的交流。</p>			

### 三、建議

感謝中華民國的國科會能夠提供此經費，讓我們能夠跟其他國家與跨領域學者相互交流，並且有機會討論合作的事宜，非常感謝！

### 四、攜回資料名稱及內容

NCM2010 Proceeding 手冊

### 五、其他

參與 NCM 研討會之照片



圖一. 於 NCM 2010(韓國首爾)報告之照片



圖二. NCM 2010 與會學者與學生合影  
(左側 1 是 keynote 演講學者日本 AIZU 大學 Jungpil Shin 博士，  
左側 2 是籌辦大會的主席 Franz Ko, Ph.D)

# Game-based Digital Learning System Assists and Motivates C Programming Language Learners

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**Abstract-Programming language beginners need interactive learning environment, show the visual executing result, compile and debug information. Learners can practice and challenge themselves in an interactive game which is full of entertaining. The proposed game-based learning environment designed most concepts in introductory C programming language and could be used in formal teaching/learning process. Learners can view the learning materials, reading/writing C codes, solving problems with C codes to control the movement of the Bomberman. Besides the user can use the server / client tool embedded voice and text chat communication to support collaborative learning via internet. Learner can study from group's collaborative learning, find and solve the problem of C programming language designing through communicating and discussing.**

## I. Introduction

The game always make interesting for people. So we want to integrate games into the learning environment. Game-based digital learning (GBL) assists teachers change their teaching functions. It provides a fun and lives up learning environment. In GBL, students have some tasks that can challenge themselves. After each task they can get encouragement. This is the most important motivation for students. Maybe the Game-based digital learning has much advantage, but it also has the weakness. For example, instructor must know the teaching materials surely. They should in according to these materials to design the game and need to adapt the leaner. In the digital learning environment, it also has many technologies help designer like the multimedia. The multimedia attract learners' attention, it focus their mind on the learning behavior.

Computer games have become an integral part of the popular culture in modern societies. Moreover, "game-based programming" is the latest buzz word in the computer science educational curriculum. Research [1] shows that students today have a totally different way of learning – react more to interactive learning. If they are not entertained while they learn, the instructor has lost them. However, much of content that needs to be learned by students today lacks of motivation to them. The word "boring", "dry" and "too technical" often crosses their lips [2]. Finally, it leads to frustration. A good game helps students to enhance their learning techniques, such as learning by doing, learning from mistakes, goal-oriented learning, discovery learning, task-based learning, question-led learning, and etc [3]. Although game-based learning has been made a good progress in academic research [4, 5, 6], using computer games for educational

purposes has been rather uncommon. Although learning by playing has been reported to education (Roussou, 2004), nevertheless, it is still less popular in post-elementary education.

C programming language is a procedural programming languages, it was spread to develop many system software. Therefore C programming is very important basic language to learn programming. We think a function to modify the learning behavior. Using game-based learning develop a system that assist students in learning activities. In this paper a new approach to the student activities that supplements the ordinary auditorium lectures is proposed. We apply a computer game, called Bomberman, to develop a C programming language course. Bomberman is a strategic maze-based computer game originally developed by Hudson Soft [7].

Collaborative learning has offered a chance to learners working together to reach a common goal. And collaborative learning uses a way of group-learning, with classmates learning together to increase their own and other classmates' awareness [8, 9]. Learners' co-operation and teamwork always support collaborative learning. Through enhancing information sharing and supporting the group process, effective collaborative learning might be reached. Improving the learner's participation and ameliorating join actively in knowledge construction by assisting creation, exchange, and analysis of information during learning group interactions, it will be made possible to increase the effectiveness of collaborative learning [10, 11 and 12]. During the collaborative learning process, all teammates will benefit from each other [13]. The approach to education that is more suitable to the educational environment through group collaborative learning. In this paper, we introduce the system architecture which we have developed, that include audio and text information communication to support co-operation and teamwork, and it has program co-editor interface [14].

The rest of this paper is organized as follows: Section 2 presents related work about our research. Section 3 introduces the main research of the system architecture implementation. Section 4 concludes this paper and discusses the future works.

## II. Related works

In this section, we are going to introduce the related work about this paper. First, we will present the theoretical background about collaborative learning. Collaboration defined "working together to complete the shared goals" [15]. Collaborative learning allows students to share their

knowledge and information each other within the problem-solving process [16]. Second, we present the ways of teaching / learning C programming language. Third, we introduce some Visualization and multimedia supported Programming Language Learning Tools. At last, we will talk about the theoretical foundations of VoIP, the technology we use in our system.

#### A. Collaborative learning

Studies have shown that collaborative learning procedures have proved to be more effective than traditional instructional methods for student's learning and academic achievement process. It also improves participants' satisfaction with the learning [11, 18]. Learning is sharing, and more shared that is more learned. It is even supposed that students are learning as much from each other as from teaching material of course or from the teacher in the class. In America, the studies have also presented that students who usually use the collaborative learning procedures in class, they have more interaction with each other, and they are more satisfied with their learning experiences. Besides, group-oriented collaborative learning, reflection and connection enhance learning.

Collaborative activities are one way of learning by allowing individuals to exercise, verify and improve their mentality through questioning, discussing and sharing information during the problem-solving process [11]. And then, collaborative learning has an obvious potential to improve critical thinking, creative thinking, elaborative thinking, social communication, and social skills (leadership, decision-making, trust-building, conflict-management, etc) [13, 19].

#### B. Teach / Learn C programming Language

C programming Language is a general-purpose, structured, procedural and imperative computer high-level programming language. It developed in 1972 by Dennis Ritchie at the Bell Telephone Laboratories for use with the Unix operating system. Although C was exploited in last three decades, it is also one of the most important and popular programming language at this time [8]. In practice, Students need to know how to [20]:

- h. Discover and understand the problem
- i. Work toward a solution
- j. Rework the solution into code
- k. Enter the code into the computer
- l. Debug syntax errors
- m. Test and debug logic errors
- n. Verify that the problem has been solved

Through these seven steps, students can learn logical thinking and how to solve the problem of C programming language. Besides these steps, students have to learn the syntax and structures of C programming language. Finally, students will accomplish more tasks and improve problem-solving skills when they master these steps.

#### C. Visualization and multimedia supported Programming Language Learning Tool

Visualization and multimedia supported software makes people learn abstract concept more easily. Mulholland [24] concluded that software visualization has to provide proper assistant for the users when they try to

learn and understand the computer programs. Users can understand easily by mapping the abstract program code and the visualization presentation. With the visualization of some specific points, users are able to test and predict the result of the executing program code. Digiano et al. [22] proposed and integrated some learning support in designing a visual programming system which is emphasized on annotatability, scriptability, monitorability, supplementability and constrainability. The five design characteristics of visual programming system addresses the educational needs of the learners. Ángel et al. [23] propose the automatic generation of visualizations and animations for programs. Students can write their program with a user-friendly system supporting generate program animations. For the teaching need, Angel et al. are devoting to develop and maintain animations. Considering friendly and useful support, such as providing simple installation packages or certain educational instructions will be beneficial to learning and teaching. Christopher and Jonathan [24] created the pedagogical algorithm visualization (AV) system which produced graphical representations to help students understand the dynamic behavior of computer algorithms. They invented the possibility of "What You See Is What You Code". In this system, each line of algorithm code is edited and reevaluated every edit. The system displayed immediate feedback along with immediate code editing.

### III. System Architecture

In order to develop a convenient and effective architecture, we use web based server-client architecture. In System architecture, learners can employ the learning and teaching tool from client. Server will save learner's learning record after they complete the test. Learners also can look for the learning progress from the web server. For the teachers, they can understand students' learning situation in the test and to assist learners some necessary learning behavior.

From the opinion of Din W. H. (2006), a successful education game has the following five main factors:

- (1)The game itself must be immersive.
- (2)The playability of the game must be elevated.
- (3)The game must be attractive, challenging, and competitive.
- (4)The game should offer a goal or several goals for players to achieve.
- (5)The game should allow players to track and manage their progress.

Followed the aforementioned characteristics and successful factors, we introduce the seven components as follows.

#### A. Road map

In order to have an overview to students, it has the "road map" function. In a sample way, it likes the catalogue to a book. So we can define it is the teaching plan from course designer. In Figure 1, the area "1" is the road map option of system. The area "2" means the history records that represent the user have pass the test. The area "3" is our main role bomberman. The area "4" is the barrier means the unit in the C programming language course.

#### B. Presentation

User can select second option “presentation”, the area “1” in Figure 2. In this function, we integrate open source Jxpose (Juanola and Lemme, 2004) to design, it is a presentation making software. Jxpose likes the “Microsoft PowerPoint” in java. Number two can choose each of the pages in our teaching material. Number three function can use the full screen and load other chapter.

### C. Example

There are two components of this function in the area “1” in Figure 3. The first component is the “Code reading”. We provide the rule explain in the area “2”. It explains the task of the example one. Let the user to understand the course correctly. In the area “3”, it will display the code to user. Another component of the example is “Run” (Figure 4). This interface can enrich the teaching contents and engage the learners. We use the graph to represent the number of array. It shows likely the area “1” and “2”. “1” is the original graph and user must to modify the code to become the “2” area. The area “3” can select the other example. Number four will compile the enter code. If the logic is no error, it will show the frame. But not surely the correct frame.

### D. Exercise

Exercise also has two components. The different between the example and exercise sub-component is the area “2”, “3” and “4” (Figure 5). In area “1” has some suggestion to learner. In area “2”, we don’t provide the code to learner. They must to write the code themselves. In exercise have a new toolbar. Number three and four can load file and save code. Number four can compile the code which the learner written. We can increase the difficulty to learner. For example, here are two kinds of fruit. After learner finish the code, they can click the area “3” to submit the code and “4” to compile the code. And the frame must to appear the same of the area “1”.

### E. Test

Most of the test functions are similar to example and exercise (Figure 6). But it is the most difficult to these three components. The result that learner must to finish show in the area “1”. Test component also can test learners’ learning situation after the look for example and practice exercise. When they finished test1, they can enter the example2. We provide a step by step learning environment.

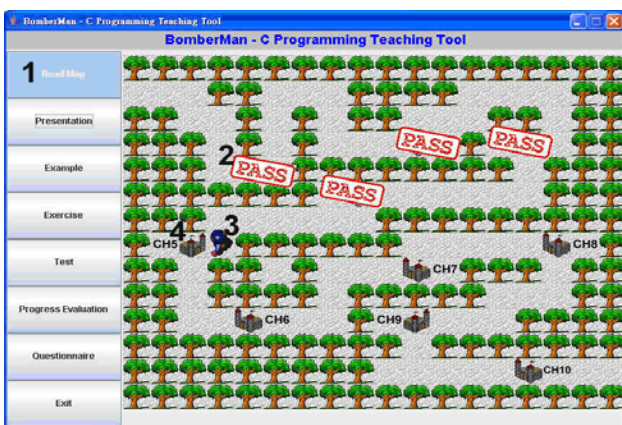


Figure 1: Road map

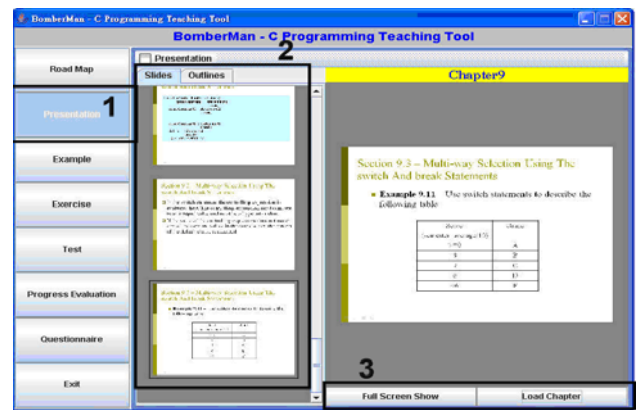


Figure 2: Presentation



Figure 3: The “Code-Reading” sub-component of example

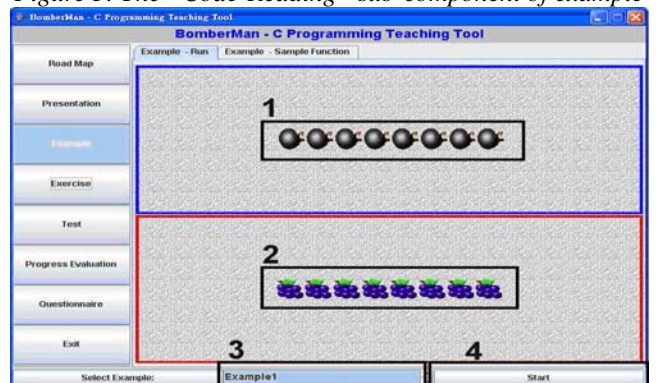


Figure 4: The “Run” sub-component of example

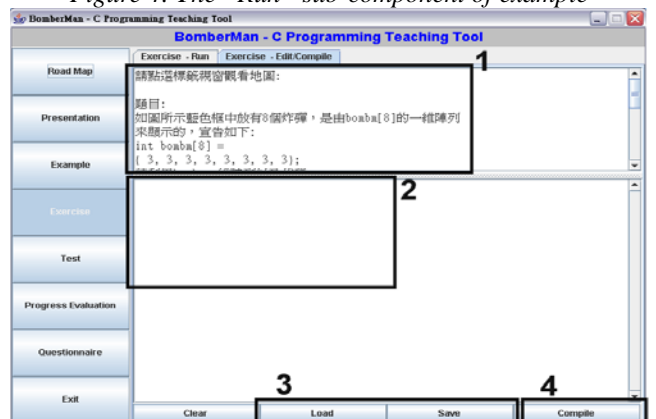


Figure 5: The “Code-Reading” sub-component of exercise

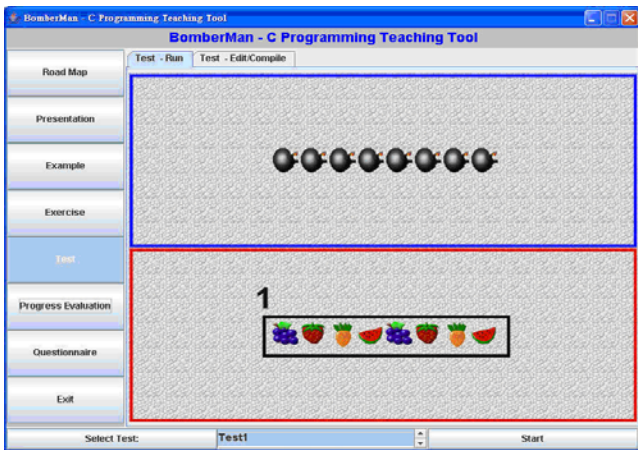


Figure 6: The “Run” sub-component of test

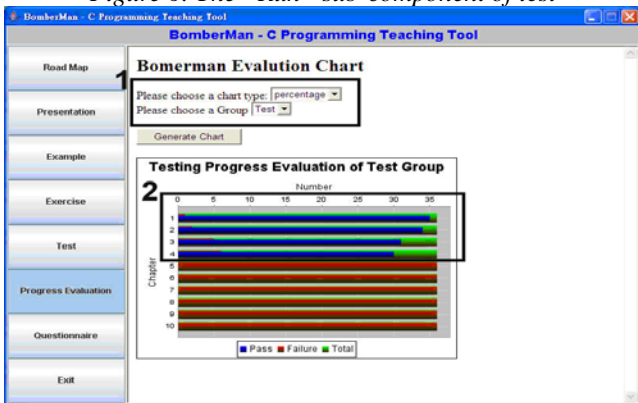


Figure 7: Progress Evaluation

#### F. Progress Evaluation

Figure 7 shows the progress evaluation which collects information from learners who can view it by themselves. The area “1” can select the chart type to show in frame and select the group which users want to know, here are two groups about the example and test. A sample progress report of a student shows in the area “2”. The report means the number of trials ranking of the tester.

#### G. Course design

The system shows an example in the upper area first, and then learners try to modify or write the code to run the lower area result exactly. There are four courses we developed in bomberman game. First course is one dimension array. Second course is two dimension arrays. Third is if-else statement. Fourth is the Switch Case statement.

There are eight bombs which can be represented in C language in the upper area. One dimension array “bombm” has eight integer elements which has C language form “int bombm[8] = { 3, 3, 3, 3, 3, 3, 3, 3};”. Each number represents one kind of fruit. 3 is bomb; 23 is grape; 24 is strawberry; 25 is carrot; 26 is watermelon.

Programming area supports learners to practice various kinds of correct code. Learners have to solve the problem with C codes by presenting four strawberries and four carrots. Learners can solve the question by four codes in the following. The second course is similar to the one dimension array.

The third mission for learners is using “if-else” statement to complete the code which assists bomberman to walk to the lower right exit. The “FLOOR” means

bomberman can pass without obstacle. There are four direction variables, RIGHT, LEFT, UP and DOWN. When the direction is RIGHT, the bomberman will go right. All the map is consisted of maze[i][j] which is a two dimension array. Therefore, maze[i][j+1] represents right position, maze[i+1][j] shows the down position. There are two correct answers for “if-else” test.

The fourth mission for learners is using “switch-case” statement to complete the code which assists bomberman sums the fruit score when crossing the fruit. Each kind of fruit has different score, grape 500, strawberry 300, carrot 200 and watermelon 100. Each figure has an individual number, Bomb (3), Grape (23), Strawberry (24), Carrot (25) and Watermelon (26). The sum of each fruit score is named as grape\_price, carrot\_price, strawberry\_price and watermelon\_price.

#### H. Cooperative Learning Tool

Considering the collaborative learning efficiency, we designed three users a team which includes one team leader and two partners to use our tool. Master server mainly controls the learner information, such as learner portfolio and information transmission. We list the functions as follows:

- User Login/Logout: When user login the system which will record the IP address and learner information. After the user logout, the system will close the editing window and terminate the connection.
- Login User: We designed three people in a study group which is consisted of group leader and two group members. Because the main purpose of our system is to assist the group's work and cooperate together, to finish their homework and task.
- Record and Communicate the Message in the Chat Room: Users can discuss how to program or what kind of function should be used in the chat room. Master server will broadcast the instant message and record the message in a text file which will be stored in system record file permanently.
- Dispatch the Program Editor Sequence Automatically: Master server dispatches the users with login order, the user has his/her own editing interface.
- User Synchronous Programming: User can edit the program in each editing window; the user program will be broadcasted to the team member after a period of time.
- Record the User Program Progress Automatically: The system will record user's program progress automatically in a period of time, in case that the users disconnect abnormally to lose the information.
- Connecting to Voice Server: Connecting and recording the voice server IP address to support voice communication service simultaneously.

A voice server supplies user communicates with voice and records the discussion. Voice server applied VoIP (Voice over IP) technique to connect all the users in real time. Voice communication is divided into group talk and private talk. Group talk furnishes users voice talk with other team members. Private talk supplies one to one discussion to solve the program writing problem.

- Program Editor: The upper side has three columns for three users to edit the program. The left window is designed for team leader, the other two windows for the team members. The system will distribute the user interface automatically. In Figure 8, team leader can arrange the sub-tasks for the other two teammates. For program writing, there will be one main program and other functions. Team leader handles the main program, the other two teammates focus on functions writing. The system will record user's program progress automatically in a period of time, in case that the users disconnect abnormally to lose the information. During the process of program writing, the user can't edit other members' editor besides his own editor.
- Chat Room: Chat room plays a role to supply a text typing mode for users who like to copy the code and communicate the programming problems. In programming course, some users have problems using the commands and variables. Some problems are suitable for text mode and some are proper to talk with voice directly. The similar situations occur in MSN communication in our daily life. Sometimes, people just like talk or type text when discussion. Therefore, we provide voice and text tools for communication.
- Debug Message Window: Debug message window shows the error message when users click the compile button in the toolbar. Leader or other partners can give suggestions to each other for correcting program error.
- Voice connecting status window: When users use [Voice Dialog], the tool launches a voice connecting status window which shows the connection status.

Users can program cooperatively with the other two teammates or learn how to write a simple program by imitating other codes. All the team has to write the program. Team leader is responsible of main program. The second user is in charge of user\_request( ) and print\_menu(). Third user writes draw\_triangle( ) and draw\_rectangle( ). They can discuss and teach each other. The partners can imitate and learn how to code C programs.

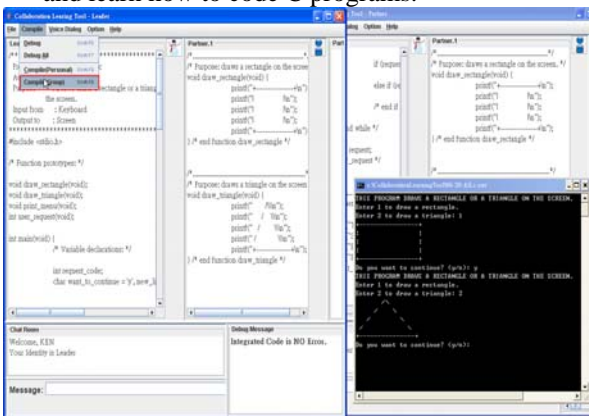


Figure 8. Editing program with teammates and support compiling and executing the program

#### IV. Conclusion and Future Works

In this paper, we develop a tool to support group collaborative learning, which combines voice and text communication mode to assist with the teamwork

more effective. Learners will learn more problem-solving skills and more knowledge of C programming language when they interact with other users using our application. Through real time discussion and information sharing, users are going to complete their homework and project more and more.

We compare the proposed system to most traditional tools and Scratch tool. The proposed system provides high interactivity and amusement than traditional tools. Scratch tool supports high interactivity, amusement and easy to use. But scratch tool is not designed for college students to study formal programming languages.

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# 行政院國家科學委員會補助國內專家學者出席國際學術會議報告

99年 8月 23日

附件三

報告人姓名	張文智	服務機構 及職稱	中華大學資訊管理系 助理教授
會議 時間 地點	99年8月16日- 99年8月18日	本會核定 補助文號	NSC 98-2511-S-216-002
會議 名稱	(中文)第六屆網路運算與進階資訊管理國際研討會 (英文) NCM2010: 6th International Conference on Networked Computing and Advanced Information Management		
發表 論文 題目	(中文) 遊戲式數位學習系統支援C語言學習 (英文) Game-based Digital Learning System Assists and Motivates C Programming Language Learners		

報告內容應包括下列各項：

## 一、參加會議經過

第一天的議程，因為班機於晚間抵達，因此無法如期參與。

第二天的議程，參加報告，並且於報告中，會議主席 chair 提出建議，在論文研究中加入驗證分析，深入探討的結果，對於論文貢獻較佳。

在會議進行中，我們本次籌辦大會的主席 Franz Ko, Ph.D，並且一同邀約明年將在台北舉辦國際研討會。透過 Franz Ko, Ph.D 的介紹，我們也認識了本次 keynote 演講學者 Jungpil Shin 博士，來自於日本 AIZU 大學，並且彼此交換研究心得與分享研究主題。

## 二、與會心得

在參與會議過程中，學者們因為有不同的學術領域與專業，因此開放的在討論中彼此交換意見與心得。

例如，詢問了報告者關於 wordnet 運用的實際範例如何運作。

論文名稱 An Automated Semantic Annotation based-on Wordnet Ontology，作者 Che-Yu Yang

例如，詢問了報告者關於 Handover 在研究理論中的模擬如何進行。

An Intelligent Handover Decision Mechanism for Heterogeneous Wireless Networks，作者 Shih Jung Wu

例如，提出行動醫療在目前台北市政府的建置與政策，提出建議。

A Personalized Healthcare Service on Aged Stroke-Precaution  
作者 Yuan-Chu Hwang

透過國際會議更了解國內外對於資訊管理領域與資訊技術領域多元的應用，對於也是需要跨領域合作的遠距教學是一種很棒的交流。

### 三、建議

感謝中華民國的國科會能夠提供此經費，讓我們能夠跟其他國家與跨領域學者相互交流，並且有機會討論合作的事宜，非常感謝！

### 四、攜回資料名稱及內容

NCM2010 Proceeding 手冊

### 五、其他

參與 NCM 研討會之照片



圖一. 於 NCM 2010(韓國首爾)報告之照片



圖二. NCM 2010 與會學者與學生合影

(左側 1 是 keynote 演講學者日本 AIZU 大學 Jungpil Shin 博士，  
左側 2 是籌辦大會的主席 Franz Ko, Ph.D)

# Game-based Digital Learning System Assists and Motivates C Programming Language Learners

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**Abstract-Programming language beginners need interactive learning environment, show the visual executing result, compile and debug information. Learners can practice and challenge themselves in an interactive game which is full of entertaining. The proposed game-based learning environment designed most concepts in introductory C programming language and could be used in formal teaching/learning process. Learners can view the learning materials, reading/writing C codes, solving problems with C codes to control the movement of the Bomberman. Besides the user can use the server / client tool embedded voice and text chat communication to support collaborative learning via internet. Learner can study from group's collaborative learning, find and solve the problem of C programming language designing through communicating and discussing.**

## I. Introduction

The game always make interesting for people. So we want to integrate games into the learning environment. Game-based digital learning (GBL) assists teachers change their teaching functions. It provides a fun and lives up learning environment. In GBL, students have some tasks that can challenge themselves. After each task they can get encouragement. This is the most important motivation for students. Maybe the Game-based digital learning has much advantage, but it also has the weakness. For example, instructor must know the teaching materials surely. They should in according to these materials to design the game and need to adapt the learner. In the digital learning environment, it also has many technologies help designer like the multimedia. The multimedia attract learners' attention, it focus their mind on the learning behavior.

Computer games have become an integral part of the popular culture in modern societies. Moreover, "game-based programming" is the latest buzz word in the computer science educational curriculum. Research [1] shows that students today have a totally different way of learning – react more to interactive learning. If they are not entertained while they learn, the instructor has lost them. However, much of content that needs to be learned by students today lacks of motivation to them. The word "boring", "dry" and "too technical" often crosses their lips [2]. Finally, it leads to frustration. A good game helps students to enhance their learning techniques, such as learning by doing, learning from mistakes, goal-oriented learning, discovery learning, task-based learning, question-led learning, and etc [3]. Although game-based learning has been made a good progress in academic research [4, 5, 6], using computer games for educational

purposes has been rather uncommon. Although learning by playing has been reported to education (Roussou, 2004), nevertheless, it is still less popular in post-elementary education.

C programming language is a procedural programming languages, it was spread to develop many system software. Therefore C programming is very important basic language to learn programming. We think a function to modify the learning behavior. Using game-based learning develop a system that assist students in learning activities. In this paper a new approach to the student activities that supplements the ordinary auditorium lectures is proposed. We apply a computer game, called Bomberman, to develop a C programming language course. Bomberman is a strategic maze-based computer game originally developed by Hudson Soft [7].

Collaborative learning has offered a chance to learners working together to reach a common goal. And collaborative learning uses a way of group-learning, with classmates learning together to increase their own and other classmates' awareness [8, 9]. Learners' co-operation and teamwork always support collaborative learning. Through enhancing information sharing and supporting the group process, effective collaborative learning might be reached. Improving the learner's participation and ameliorating join actively in knowledge construction by assisting creation, exchange, and analysis of information during learning group interactions, it will be made possible to increase the effectiveness of collaborative learning [10, 11 and 12]. During the collaborative learning process, all teammates will benefit from each other [13]. The approach to education that is more suitable to the educational environment through group collaborative learning. In this paper, we introduce the system architecture which we have developed, that include audio and text information communication to support co-operation and teamwork, and it has program co-editor interface [14].

The rest of this paper is organized as follows: Section 2 presents related work about our research. Section 3 introduces the main research of the system architecture implementation. Section 4 concludes this paper and discusses the future works.

## II. Related works

In this section, we are going to introduce the related work about this paper. First, we will present the theoretical background about collaborative learning. Collaboration defined "working together to complete the shared goals" [15]. Collaborative learning allows students to share their

knowledge and information each other within the problem-solving process [16]. Second, we present the ways of teaching / learning C programming language. Third, we introduce some Visualization and multimedia supported Programming Language Learning Tools. At last, we will talk about the theoretical foundations of VoIP, the technology we use in our system.

#### A. Collaborative learning

Studies have shown that collaborative learning procedures have proved to be more effective than traditional instructional methods for student's learning and academic achievement process. It also improves participants' satisfaction with the learning [11, 18]. Learning is sharing, and more shared that is more learned. It is even supposed that students are learning as much from each other as from teaching material of course or from the teacher in the class. In America, the studies have also presented that students who usually use the collaborative learning procedures in class, they have more interaction with each other, and they are more satisfied with their learning experiences. Besides, group-oriented collaborative learning, reflection and connection enhance learning.

Collaborative activities are one way of learning by allowing individuals to exercise, verify and improve their mentality through questioning, discussing and sharing information during the problem-solving process [11]. And then, collaborative learning has an obvious potential to improve critical thinking, creative thinking, elaborative thinking, social communication, and social skills (leadership, decision-making, trust-building, conflict-management, etc) [13, 19].

#### B. Teach / Learn C programming Language

C programming Language is a general-purpose, structured, procedural and imperative computer high-level programming language. It developed in 1972 by Dennis Ritchie at the Bell Telephone Laboratories for use with the Unix operating system. Although C was exploited in last three decades, it is also one of the most important and popular programming language at this time [8]. In practice, Students need to know how to [20]:

- a. Discover and understand the problem
- b. Work toward a solution
- c. Rework the solution into code
- d. Enter the code into the computer
- e. Debug syntax errors
- f. Test and debug logic errors
- g. Verify that the problem has been solved

Through these seven steps, students can learn logical thinking and how to solve the problem of C programming language. Besides these steps, students have to learn the syntax and structures of C programming language. Finally, students will accomplish more tasks and improve problem-solving skills when they master these steps.

#### C. Visualization and multimedia supported Programming Language Learning Tool

Visualization and multimedia supported software makes people learn abstract concept more easily. Mulholland [24] concluded that software visualization has to provide proper assistant for the users when they try to

learn and understand the computer programs. Users can understand easily by mapping the abstract program code and the visualization presentation. With the visualization of some specific points, users are able to test and predict the result of the executing program code. Digiano et al. [22] proposed and integrated some learning support in designing a visual programming system which is emphasized on annotatability, scriptability, monitorability, supplementability and constrainability. The five design characteristics of visual programming system addresses the educational needs of the learners. Ángel et al. [23] propose the automatic generation of visualizations and animations for programs. Students can write their program with a user-friendly system supporting generate program animations. For the teaching need, Angel et al. are devoting to develop and maintain animations. Considering friendly and useful support, such as providing simple installation packages or certain educational instructions will be beneficial to learning and teaching. Christopher and Jonathan [24] created the pedagogical algorithm visualization (AV) system which produced graphical representations to help students understand the dynamic behavior of computer algorithms. They invented the possibility of "What You See Is What You Code". In this system, each line of algorithm code is edited and reevaluated every edit. The system displayed immediate feedback along with immediate code editing.

### III. System Architecture

In order to develop a convenient and effective architecture, we use web based server-client architecture. In System architecture, learners can employ the learning and teaching tool from client. Server will save learner's learning record after they complete the test. Learners also can look for the learning progress from the web server. For the teachers, they can understand students' learning situation in the test and to assist learners some necessary learning behavior.

From the opinion of Din W. H. (2006), a successful education game has the following five main factors:

- (1)The game itself must be immersive.
- (2)The playability of the game must be elevated.
- (3)The game must be attractive, challenging, and competitive.
- (4)The game should offer a goal or several goals for players to achieve.
- (5)The game should allow players to track and manage their progress.

Followed the aforementioned characteristics and successful factors, we introduce the seven components as follows.

#### A. Road map

In order to have an overview to students, it has the "road map" function. In a sample way, it likes the catalogue to a book. So we can define it is the teaching plan from course designer. In Figure 1, the area "1" is the road map option of system. The area "2" means the history records that represent the user have pass the test. The area "3" is our main role bomberman. The area "4" is the barrier means the unit in the C programming language course.

#### B. Presentation

User can select second option “presentation”, the area “1” in Figure 2. In this function, we integrate open source Jxpose (Juanola and Lemme, 2004) to design, it is a presentation making software. Jxpose likes the “Microsoft PowerPoint” in java. Number two can choose each of the pages in our teaching material. Number three function can use the full screen and load other chapter.

### C. Example

There are two components of this function in the area “1” in Figure 3. The first component is the “Code reading”. We provide the rule explain in the area “2”. It explains the task of the example one. Let the user to understand the course correctly. In the area “3”, it will display the code to user. Another component of the example is “Run” (Figure 4). This interface can enrich the teaching contents and engage the learners. We use the graph to represent the number of array. It shows likely the area “1” and “2”. “1” is the original graph and user must to modify the code to become the “2” area. The area “3” can select the other example. Number four will compile the enter code. If the logic is no error, it will show the frame. But not surely the correct frame.

### D. Exercise

Exercise also has two components. The different between the example and exercise sub-component is the area “2”, “3” and “4” (Figure 5). In area “1” has some suggestion to learner. In area “2”, we don’t provide the code to learner. They must to write the code themselves. In exercise have a new toolbar. Number three and four can load file and save code. Number four can compile the code which the learner written. We can increase the difficulty to learner. For example, here are two kinds of fruit. After learner finish the code, they can click the area “3” to submit the code and “4” to compile the code. And the frame must to appear the same of the area “1”.

### E. Test

Most of the test functions are similar to example and exercise (Figure 6). But it is the most difficult to these three components. The result that learner must to finish show in the area “1”. Test component also can test learners’ learning situation after the look for example and practice exercise. When they finished test1, they can enter the example2. We provide a step by step learning environment.

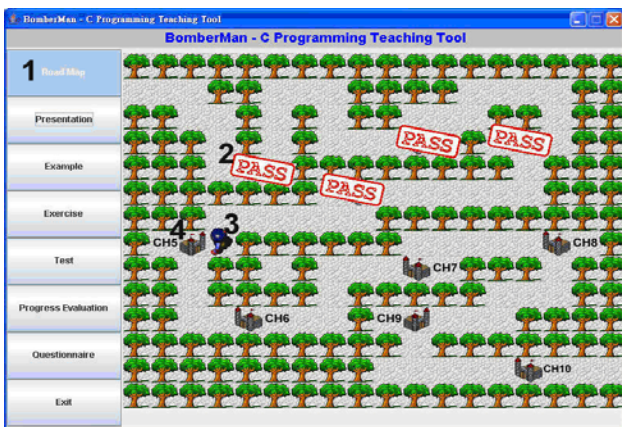


Figure 1: Road map

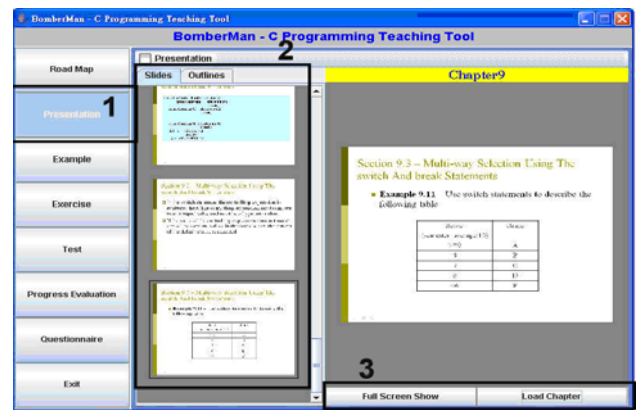


Figure 2: Presentation



Figure 3: The “Code-Reading” sub-component of example

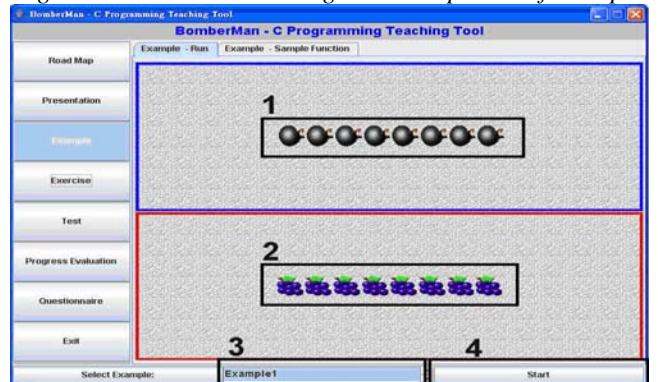


Figure 4: The “Run” sub-component of example

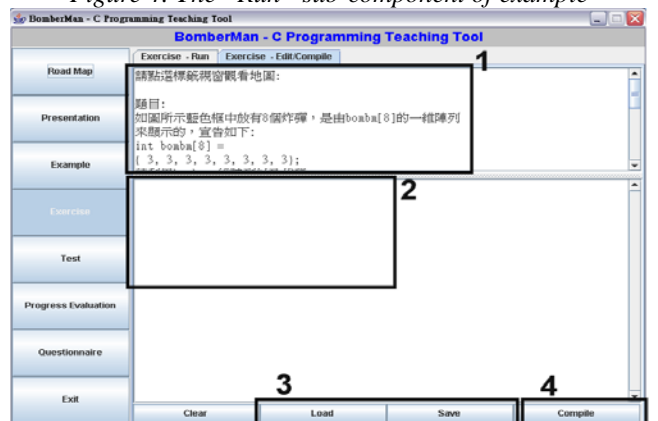


Figure 5: The “Code-Reading” sub-component of exercise

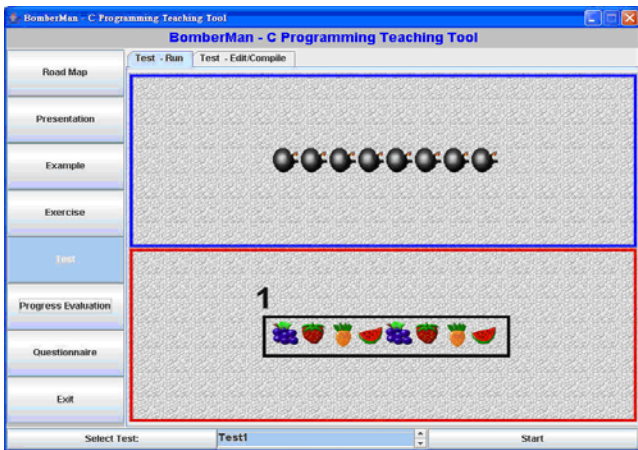


Figure 6: The “Run” sub-component of test

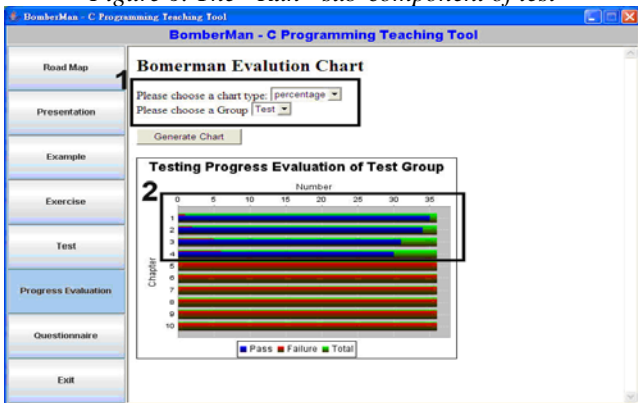


Figure 7: Progress Evaluation

#### F. Progress Evaluation

Figure 7 shows the progress evaluation which collects information from learners who can view it by themselves. The area “1” can select the chart type to show in frame and select the group which users want to know, here are two groups about the example and test. A sample progress report of a student shows in the area “2”. The report means the number of trials ranking of the tester.

#### G. Course design

The system shows an example in the upper area first, and then learners try to modify or write the code to run the lower area result exactly. There are four courses we developed in bomberman game. First course is one dimension array. Second course is two dimension arrays. Third is if-else statement. Fourth is the Switch Case statement.

There are eight bombs which can be represented in C language in the upper area. One dimension array “bombm” has eight integer elements which has C language form “int bombm[8] = { 3, 3, 3, 3, 3, 3, 3, 3};”. Each number represents one kind of fruit. 3 is bomb; 23 is grape; 24 is strawberry; 25 is carrot; 26 is watermelon.

Programming area supports learners to practice various kinds of correct code. Learners have to solve the problem with C codes by presenting four strawberries and four carrots. Learners can solve the question by four codes in the following. The second course is similar to the one dimension array.

The third mission for learners is using “if-else” statement to complete the code which assists bomberman to walk to the lower right exit. The “FLOOR” means

bomberman can pass without obstacle. There are four direction variables, RIGHT, LEFT, UP and DOWN. When the direction is RIGHT, the bomberman will go right. All the map is consisted of maze[i][j] which is a two dimension array. Therefore, maze[i][j+1] represents right position, maze[i+1][j] shows the down position. There are two correct answers for “if-else” test.

The fourth mission for learners is using “switch-case” statement to complete the code which assists bomberman sums the fruit score when crossing the fruit. Each kind of fruit has different score, grape 500, strawberry 300, carrot 200 and watermelon 100. Each figure has an individual number, Bomb (3), Grape (23), Strawberry (24), Carrot (25) and Watermelon (26). The sum of each fruit score is named as grape\_price, carrot\_price, strawberry\_price and watermelon\_price.

#### H. Cooperative Learning Tool

Considering the collaborative learning efficiency, we designed three users a team which includes one team leader and two partners to use our tool. Master server mainly controls the learner information, such as learner portfolio and information transmission. We list the functions as follows:

- User Login/Logout: When user login the system which will record the IP address and learner information. After the user logout, the system will close the editing window and terminate the connection.
- Login User: We designed three people in a study group which is consisted of group leader and two group members. Because the main purpose of our system is to assist the group's work and cooperate together, to finish their homework and task.
- Record and Communicate the Message in the Chat Room: Users can discuss how to program or what kind of function should be used in the chat room. Master server will broadcast the instant message and record the message in a text file which will be stored in system record file permanently.
- Dispatch the Program Editor Sequence Automatically: Master server dispatches the users with login order, the user has his/her own editing interface.
- User Synchronous Programming: User can edit the program in each editing window; the user program will be broadcasted to the team member after a period of time.
- Record the User Program Progress Automatically: The system will record user's program progress automatically in a period of time, in case that the users disconnect abnormally to lose the information.
- Connecting to Voice Server: Connecting and recording the voice server IP address to support voice communication service simultaneously.

A voice server supplies user communicates with voice and records the discussion. Voice server applied VoIP (Voice over IP) technique to connect all the users in real time. Voice communication is divided into group talk and private talk. Group talk furnishes users voice talk with other team members. Private talk supplies one to one discussion to solve the program writing problem.



- Program Editor: The upper side has three columns for three users to edit the program. The left window is designed for team leader, the other two windows for the team members. The system will distribute the user interface automatically. In Figure 8, team leader can arrange the sub-tasks for the other two teammates. For program writing, there will be one main program and other functions. Team leader handles the main program, the other two teammates focus on functions writing. The system will record user's program progress automatically in a period of time, in case that the users disconnect abnormally to lose the information. During the process of program writing, the user can't edit other members' editor besides his own editor.
- Chat Room: Chat room plays a role to supply a text typing mode for users who like to copy the code and communicate the programming problems. In programming course, some users have problems using the commands and variables. Some problems are suitable for text mode and some are proper to talk with voice directly. The similar situations occur in MSN communication in our daily life. Sometimes, people just like talk or type text when discussion. Therefore, we provide voice and text tools for communication.
- Debug Message Window: Debug message window shows the error message when users click the compile button in the toolbar. Leader or other partners can give suggestions to each other for correcting program error.
- Voice connecting status window: When users use [Voice Dialog], the tool launches a voice connecting status window which shows the connection status.

Users can program cooperatively with the other two teammates or learn how to write a simple program by imitating other codes. All the team has to write the program. Team leader is responsible of main program. The second user is in charge of user\_request() and print\_menu(). Third user writes draw\_triangle() and draw\_rectangle(). They can discuss and teach each other. The partners can imitate and learn how to code C programs.

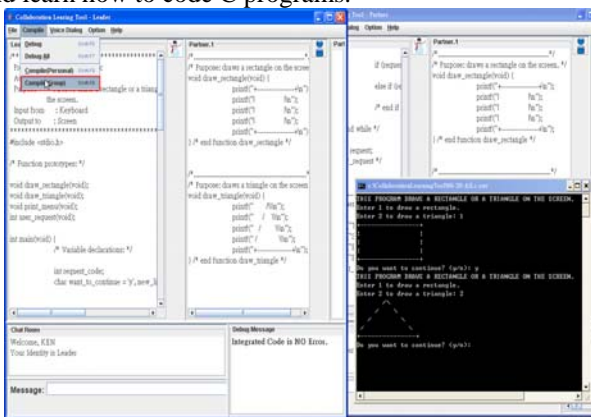


Figure 8. Editing program with teammates and support compiling and executing the program

#### IV. Conclusion and Future Works

In this paper, we develop a tool to support group collaborative learning, which combines voice and text communication mode to assist with the teamwork more effective. Learners will learn more problem-solving skills

and more knowledge of C programming language when they interact with other users using our application. Through real time discussion and information sharing, users are going to complete their homework and project more and more.

We compare the proposed system to most traditional tools and Scratch tool. The proposed system provides high interactivity and amusement than traditional tools. Scratch tool supports high interactivity, amusement and easy to use. But scratch tool is not designed for college students to study formal programming languages.

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無研發成果推廣資料

98 年度專題研究計畫研究成果彙整表

計畫主持人：張文智		計畫編號：98-2511-S-216-002-				計畫名稱：炸彈超人遊戲式教學與合作學習系統-以 C 語言教學為例		
成果項目		量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）		
		實際已達成數（被接受或已發表）	預期總達成數（含實際已達成數）	本計畫實際貢獻百分比				
國內	論文著作	期刊論文	0	0	100%	篇		
		研究報告/技術報告	0	0	100%			
		研討會論文	0	0	100%			
		專書	0	0	100%			
	專利	申請中件數	0	0	100%	件		
		已獲得件數	0	0	100%			
	技術移轉	件數	0	0	100%	件		
		權利金	0	0	100%	千元		
	參與計畫人力（本國籍）	碩士生	5	3	100%	人次		
		博士生	0	0	100%			
博士後研究員		0	0	100%				
專任助理		0	0	100%				
國外	論文著作	期刊論文	1	1	100%	篇	目前投稿其中一篇[條件通過]，正在修改中與審查中。	
		研究報告/技術報告	0	0	100%			
		研討會論文	3	3	100%			已發表 3 篇國際研討會論文，將朝向期刊努力。
		專書	0	0	100%		章/本	
	專利	申請中件數	0	0	100%	件		
		已獲得件數	0	0	100%			
	技術移轉	件數	0	0	100%	件		
		權利金	0	0	100%	千元		
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次		
		博士生	0	0	100%			
		博士後研究員	0	0	100%			
		專任助理	0	0	100%			

<p>其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)</p>	<p>無</p>
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	成果項目	量化	名稱或內容性質簡述
科 教 處 計 畫 加 填 項 目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	2	發展一個遊戲式平台與合作式學習平台
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與(閱聽)人數	0	



# 國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

達成目標

未達成目標（請說明，以 100 字為限）

實驗失敗

因故實驗中斷

其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文： 已發表  未發表之文稿  撰寫中  無

專利： 已獲得  申請中  無

技轉： 已技轉  洽談中  無

其他：（以 100 字為限）

本計畫內容目前發表了三篇國際研討會，目前已經投稿到兩個國際期刊。

主要針對遊戲式學習 C 語言與合作是開發 C 語言的系統做整合與應用。目前朝向國際期刊發表努力。

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

本計畫主要發展一個遊戲式學習融合合作學習平台的學習系統，主要發展的科目是 C 語言。透過本計畫的研發，這樣的架構可以運用在其他的程式設計學習與發展。一方面幫助學習者透過合作式平台學習來加強學習效果，一方面提供遊戲式方式吸引學習者學習動機。視覺化的呈現程式設計遊戲狀況。