Special Issue

Using C/C++ Internet Community Judge System in Programming Course

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Abstract — The purpose of this study is to explore how to use C/C++ Internet Community Judge System (CICJS) on programming course effects the learning achievements of students at senior high school level. This study is mainly conducted by "a quasi-experimental design". It also adopts "questionnaire survey" as auxiliary support. In the 6-week study, 208 students from researcher's 4 classes were selected. The researcher has been teaching computer programming courses at senior high school for many years while many difficulties in programming instruction are appeared in practice. To overcome those difficulties ahead, this study develops an online CICJS on Facebook, based on the universality and highly interactive online community of Facebook in Taiwan.

The major findings of this study are shown as follows,

1. The results of the experiment indicate that more improvements are found in low achievement student.

2. "Peer relation" shows significant effect on the learning satisfaction of students.

3. The number of response to others request for help shows significant positive correlation with learning satisfaction.

Finally, the implications of this study also are discussed. To conduct the effectiveness of CICJS will be explored in the days to come.

Index Terms-- programming instruction, scaffolding theory, peer learning, C/C++ Internet Community Judge System (CICJS)

I. INTRODUCTION

Due to the new lesson outline of the adaptive and multi-elective trend in programming course in Taiwan, the high school the researcher serves tried to provide aptitude test opportunity for students. Then, the C / C + + programming design course have been delivered in recent years. Moreover, students are more interesting to programming with curiosity while mobile phone App wave rises. The instruction of programming courses is still facing many difficulties for high school students in Taiwan.

After investigation of experiences about the problems encountered by the programming design instruction, this study intends to solve the problem and aims : (1) To provide students with an efficient exercise program; (2) To enable students to attain outside support beyond teachers when they face difficulties; (3) To maintain the students' learning motivation in the programming course learning. Based on those goals, the development in this study is C/C + + Internet Community Judge System (CICJS), an online programming evaluation system.

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This study attempts to develop C/C++ Internet Community Judge System (CICJS) with online problem-solving. So CICJS can verify the C / C + + programming language validity and do interactive feedback for students when the programming bugs are syntax errors. Beyond the syntax bugs, those students can call for help to community members who are enthusiastic or benevolent. So the 2 research questions in this study are:

1. To explore the effectiveness of CICJS enhancing students' learning programming.

2. To explore peer learning in CICJS to enhance students' satisfaction of learning programming.

II. RELATED WORKS

To meet the research goals, this section will make related works on scaffolding theory, peer learning, online community, and programming instruction.

A. *Scaffolding Theory*

Instructional scaffolding is a learning process designed to promote a deeper learning. Scaffolding is the support given during the learning process which is tailored to the needs of the student with the intention of helping the student achieve his/her learning goals[1]. So instructional scaffolding is the provision of sufficient support to promote learning when concepts and skills are being first introduced to students. These supports may include the following:

- Resources
- A compelling task
- Templates and guides
- Guidance on the development of cognitive and social skills

In terms of using instructional scaffolding in various contexts such as modeling a task, giving advice, or providing coaching. These supports are gradually removed as students develop autonomous learning strategies as times go by [2] [3] [4]. Based on Zone of Proximal Development (ZPD) by Vygosky[4], the difference between what learners can do without help and what he or she can do with help. Those students can attain different ways of support from teachers and peers in an online community.

B. *Peer learning*

Research shows that peer learning activities typically result in: (a) Team-building spirit and more supportive relationships; (b) Greater psychological well-being, social competence, communication skills and self-esteem; and (c) Higher achievement and greater productivity in terms of

enhanced learning outcomes. In peer learning community, a mentor with more experiences would like to support other members or tutees via learning by teaching method. Although peer-learning strategies are valuable tools for educators to utilize, it is obvious that simply placing students in groups and telling them to 'work together' is not going to automatically yield results. The teacher must consciously orchestrate the learning exercise and choose the appropriate vehicle for it. Only then will students in fact engage in peer learning and reap the benefits discussed above[5] [6] [7] [8].

C. *Network Community*

The Virtual Community examines the social and political ramifications of computer networking which, in Rheingold's view [9], is having a profound effect on the nature of democratic discourse. He suggests that computer-based communication has introduced a new form of human social life called "Virtual Communities"-- groups of people linked by their participation in computer networks. While Digital Natives were born in the digital environment for young students in Taiwan, they can quickly receive information and deal with information simultaneously beyond their parents' generation. They feel more comfortable when they use hypertext randomly or they connect to the network with better performance than their parents [10].[11][12].

D. *Programming Instruction*

To overcome the plight of programming instruction, many researchers are trying to propose solutions. Hereby listed as follows:

(1) Peer learning: Try to build a programming languages platform to support peer learning [13].
(2) Test validity of students' work: under computers' capability of debugging, it gives tips to provide students how to write a correct program [14].
(3) Curriculum design complied with sequential principles: being guided by a simple example to enhance students' sense of accomplishment and self-confidence, or to eliminate fear of hardship for beginners [15].
(4) Case Method: Select a representative practical example, the programming content into the instance in [16].
(5) Implementing practice: Teaching content made films for online viewing by students according to their need to reduce the teaching time and to allow students more practice [17].

Currently, to assist tools in programming instruction has two categories: (1) an interactive graphical programming environment based on the mini-language: such as "Alice" developed at the University of Carnegie Mellon University, USA, "Scratch" developed at Massachusetts Institute of Technology, USA. (2) An online evaluation system based on the actual programming language, such as ZeroJudge, developed at Affiliated High School, National Kaohsiung Normal University, Taiwan or, PASS (Programming Assignment Assessment system), developed at City University of Hong Kong, China.

III. RESEARCH METHODOLOGY

In this study, a quasi-experiment is conducted to explore CICJS in C / C + + programming courses for the students' learning effectiveness at high school levels.

A. *Research Variables*

Three research variables are categorized as (a) independent variables: The Higher, Middle, and Lower degrees based upon 25%, 50%, and 25% from top to bottom grade in the pre-test, (b)Dependent variables : Learning satisfaction and learning outcome, (c) Control variables: teacher, teaching content and teaching hours.

B. *Research subject*

The subjects of this study consist of 208 students from 4 classes at National Nei-Li Senior High School (NLSHS), Taoyuan County, Taiwan.

C. *Research Tools*

Research tools in this study consist of programming textbooks with notes and practice, learning achievement test, a learning satisfaction questionnaire with 5-Linkert scale and subject matter experts' verification, an online community evaluation system on Facebook platform developed by researchers with graph API in Fig. 1.

D. *Research Processes*

A CICJS was developed as Facebook App in Fig. 1. The major architecture of CICJS has 2 parts: (1) Software: Community network on Facebook, and (2) Hardware: A server located at NSHS.

On the server site, 6 components are (1) User Management with user login and classification in Fig. 2; (2) Exercises Management with authoring tools to edit the exercises by teachers in Fig. 3; (3) Course Management with course listing in Fig. 4; (4) Real-time Evaluation with debugging listing in Fig. 5; (5) Online help with 6 dialogues such as Call for Help, Practice Program, Coding, Error Messages, Richtext Whiteboard, and Real-time chat in Fig. 6 & Fig. 7; and (6) Learning portfolios in Fig. 8. The learning portfolio for each student gives teachers hints to assist students' learning programming when teachers use them right.

IV. RESEARCH RESULTS AND DISCUSSIONS

A. *Learning outcome*

Based on grade differences (Post-test – Pre-test), these 3 groups from Higher, Middle, and Lower achievement of students attain 1.94, 5.56, and 11.68 respectively. By one-way ANOVA, there are significant differences for Middle, and Lower achievement students in using CICJS to learn programming. In other words, the CICJS do benefit best for lower achievement students.

Fig 1 CICJS system when students login

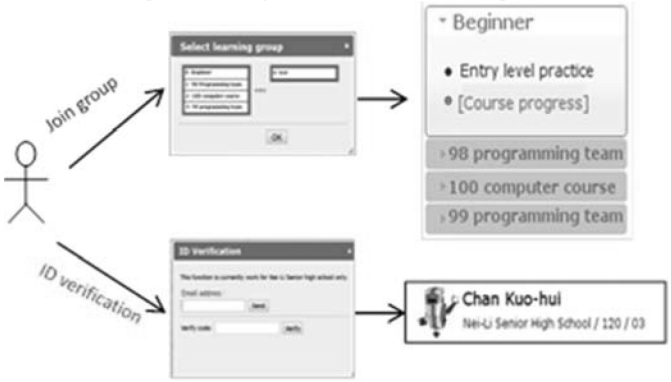

Fig. 2 Users join the group and login verification

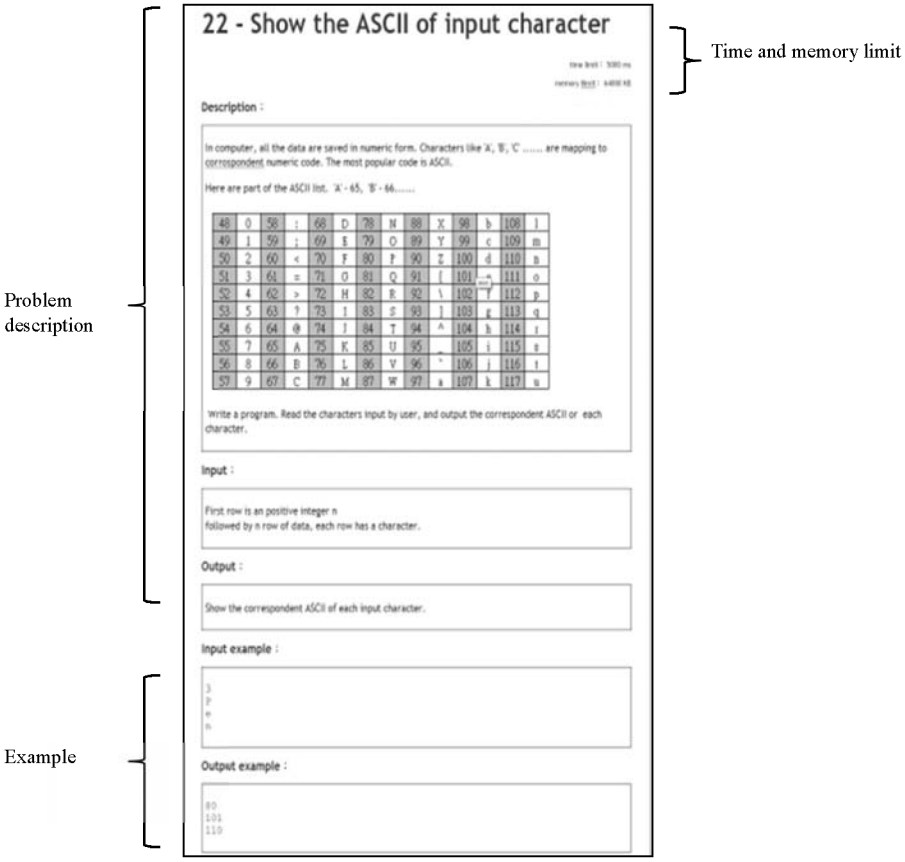

Fig. 3 A sample of exercise developed by authoring tools

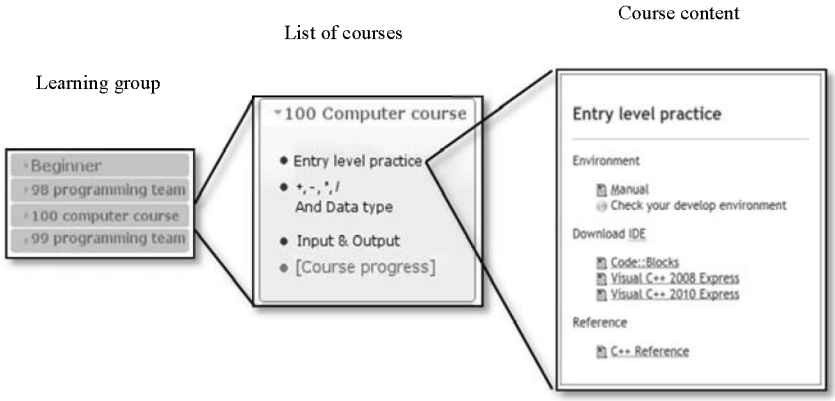

Fig. 4: Course contents designed as hierarchical structure

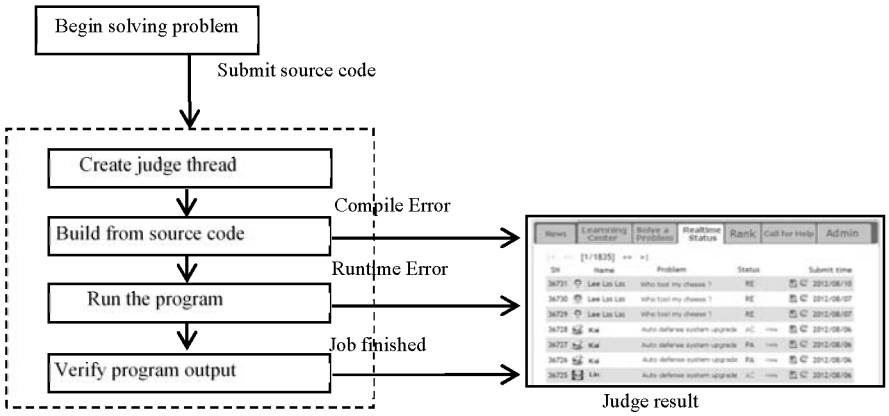

Fig. 5 Flowchart of debugging programs

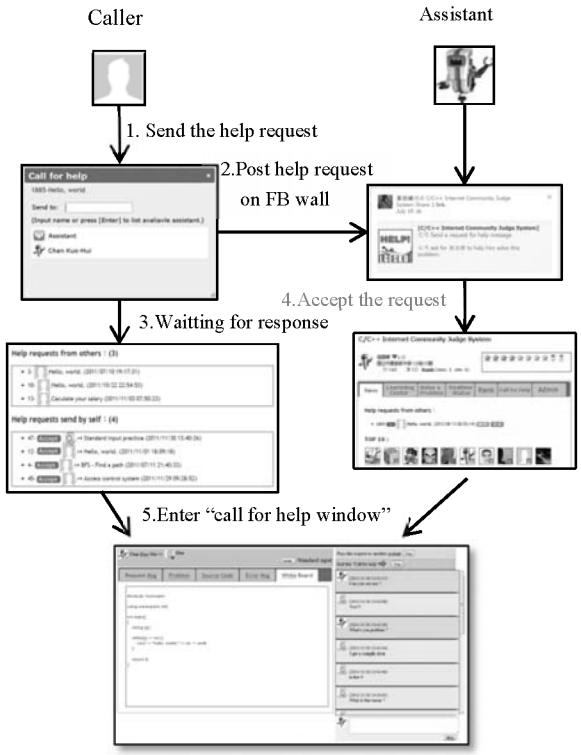

Fig. 6: The flowchart of online help

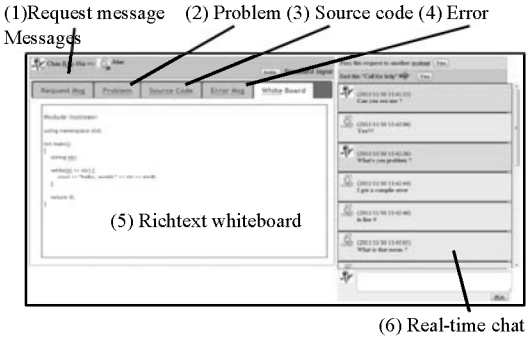

Fig. 7: Call for help Window with 6 functionalities

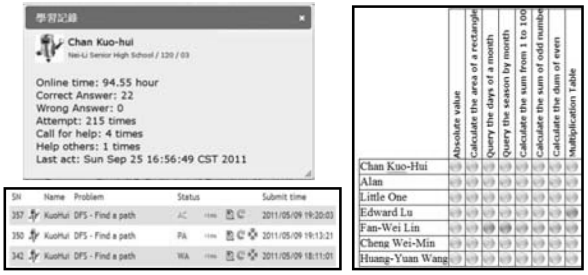

Fig. 8 A Sample of learning portfolio at CICJS

In terms of grouping, three variables consist of online at school, online after school, and the number of problem solving. Under Pearson product-moment correlation was shown in Table 1.

Table 1: Learning outcome in using CICJS analyzed by Pearson's product-moment correlation

Group	Online at school	Online after school	# of problem solving tried
Higher	0.411(p=0.002)	0.349(p=0.001)	0.440(p=0.006)
Middle	0.368(p=0.001)	0.370(p<0.001)	0.341(p<0.001)
Lower	0.343(p<0.001)	0.409(p<0.001)	0.347(p<0.001)

Table 1 indicates doing more exercises is highly correlated with learning outcome for higher achievement group. The other 2 groups are highly correlated with students who spent much time after school.

B. *Learning Satisfaction*

The number of effective questionnaires collected is 205. The Cronbach's Alpha value of the questionnaires in this study is 0.896.

By one-way ANOVA, $p<0.05$ indicates the highly significant difference among 3 groups and p-value ($0.003<0.05$) for the Higher achievement vs. Lower achievement group shows significant different between 2 groups.

By group as independent variable, the peer learning in the Lower Achievement Group attain lowest satisfaction when compared with p-value at other 2 groups (Higher Achievement Group vs. Lower Achievement Group, and Middle Achievement Group vs. Lower Achievement Group) are 0.001 and 0.009 respectively.

C. *Peer-learning analyses*

The reason why CICJS was designed on Facebook platform instead of an independent system is to enhance peer coaching or interaction among those students. In this experiment, 89 students (43.41%) used the online help system and 43 students (20.97%) did help other students. Table 2 shows that the "Middle" achievement students actively called for help with highest frequency (47.12%). The higher the "Higher" achievement students actively replied help with highest ratio frequency (33.33%).

Table 2 The number of call for help in different groups

Group	# of students	Call for help	Reply help
Higher	51	28 (54.90%)	17 (33.33%)
Middle	104	49 (47.12%)	22 (21.15%)
Lower	50	12 (24%)	4 (8%)
Total	205	89	43

In the questionnaire of this study, the results show that students in using the online help system indeed solved the difficulties they encountered. The average Score for online help is highly confirmed at 4.93 in terms of peer coaching while peers can resolve their difficulties interactively. Also, the helper show a great sense of accomplishment when they helped others to learn. The outcome of the online help system interactions reaches 4.88 in terms of average grade. On the contrary, the "Lower" achievement students who participating online interactions are quite low, this may be the main cause of the "Lower" achievement students in the "peer relationships" significantly low satisfaction.

Additionally, using "the number of Issuing requests for assistance "and "the number of responding to others" as independent variables, learning satisfaction is significantly positive with those 2 independent variables. Table 3 indicates Correlation between learning satisfactions and peer learning analyzed by Pearson's product-moment correlation.

Table 3 Correlation between learning satisfactions and peer learning analyzed by Pearson's product-moment correlation

	# of Issuing requests for assistance	# of responding to others
Learning satisfactions grade	0.022(p=0.418)	0.23(p=0.015)

V. CONCLUSIONS AND RECOMMENDATIONS

The major findings of this study are shown as follows,

1. The results of the experiment indicate that more improvements are found in low achievement student.
2. "Peer relation" shows significant effect on the learning satisfaction of students.
3. The number of response to others request for help shows significant positive correlation with learning satisfaction.

As for the recommendations for future study, three recommendations are shown follows,

1. To develop more course to verify the CICJS platform.

2. To provide sufficient online assistant to assist students' learning programming.
3. To make use of data mining to discover where students' learning difficulties.

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BIOGRAPHIES

Jin Tan David Yang received the M.S. and PhD. from the Department of Computer Science, SUNYAB, Buffalo, NY, USA in 1985 and the Department of Education, University of Oregon, Eugene, OR, USA in 1993.

He was a lecture, associate professor, and professor at National Kaohsiung Normal University, Taiwan for 21 years (from 1987~2008). He was a co-chair of ICALT, an important e-learning international conference, held in Kaohsiung city, Taiwan in 2005. Then, he moved to Ming Chuan University (MCU), Taipei, Taiwan in 2008. Now, he is a professor at Graduate School of Education, MCU. His research and teaching interests are educational research, programming language, artificial intelligence, and e-Learning applications etc.

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