A web based programming learning management system with JavaScript libraries

Shimpei Matsumoto†  Shuichi Yamagishi†  Tomoko Kashima‡
†Faculty of Applied Information Science, Hiroshima Institute of Technology
‡Faculty of Engineering, Kinki University
†{s.matsumoto.gk, s.yamagishi.if}@cc.it-hiroshima.ac.jp
‡kashima@hiro.kindai.ac.jp

Abstract
A web based programming learning management system is now planned to be developed aiming for the holistic improvement of understanding for programming. The system is for students who are not good at programming and are with insufficient understanding, and the system aims to train their skills by the after class hour learning. Before the authors develop the software, this paper addresses to give the part of the specification of the software. Especially as the first step, this paper examines what kind of students are no good at programming, and what needs to improve the understanding of the students. The authors consider that the trends and characteristics of students with low programming skill need to be shown in supporting their learning. The short exams were conducted in several times in lectures related to programming for the first and second grade students currently being held, and the results were examined depending on the achievement degree of students. From the analysis, the valuable speculation about students who are no good at programming was obtained.

Keywords: Programming, Algorithm, Learning support, Web, JavaScript, Puzzle, Entertainment

1 Introduction
Information systems technology is essential for today’s highly-sophisticated information society, and the demand in society for engineers of IT has been extremely high. Therefore various educations on IT have been practiced in the departments of informatics or related fields in higher educational institutions mainly universities. Specifically in the efforts of these institutions, educations in programming related subjects including software engineering, numerical computation, algorithm theory, and object oriented modeling has been emphasized because these programming techniques is absolutely necessary to build information systems. Many companies require high-level programming skill for university students majoring informatics. Therefore each educational institution should devise an efficient educational method more for programming related lectures.

The authors have taught some programming related subjects, introduction to algorithm for freshmen, introduction to the C programming language for freshmen, and applied algorithm for sophomores with traditional common lecture style for several years, but the authors could not have provided enough guidance to overcome a lack of the understanding for students who are not good at programming. As far as the authors verify, every year there are inevitably students in definite proportions who are not good at programming, and the trend is thought to be similar between each grade. Interestingly, the reference [2], a quite famous paper on the web in spite of it was not officially published, reported a similar result; students not good at programming certainly exist at a constant rate regardless of gender, age, and educational level.

Based on the above background, the authors began educational research of programming related subjects for improving the overall level of programming technique. Concretely speaking, construction of programming self-studying environment with visual and intuitive operation, which can generate interest in programming, is targeted as the final goal. As the self-studying environment, an Internet accessible programming learning management system (PLMS) is planned to be developed and introduced, which enables to enjoy learning of the basic perspective of programming by giving entertainment factor. Firstly this paper clarified the character and functions of PLMS to implement by objectively
analyzing all students’ programming skill with some examinations conducted in actual lecture. From the result of the analysis, beneficial knowledge to design a PLMS was disclosed. With the knowledge, prototype of a PLMS was developed on the basis of user friendly learning function like puzzle games. The PLMS focuses on students who want to be good at programming but right now they are not good at. This paper presents game like programming learning questions with Google Blockly and enchant.js, JavaScript libraries, which aims to automatically move a robot from start point to goal point by giving an algorithm consisted of some pieces with proper order, each of which corresponds to an instruction to move.

2 Related Works

Earlier researches on programming are roughly classified into two subjects: the one is on the teaching method for programming learning, and the other is on the development of programming learning support system. For example, Fukamachi showed the typical mistakes of which liberal arts students are likely to misunderstand for learning computer programming by giving specific examples, and addressed the improvement of lecture for liberal arts students [1]. Fukamachi indicated that the major factors for preventing programming learning are lack of ability to interpret mathematical formulae, and lack of experience to express one’s thinking with mathematical formulae and training to do this. Fukamachi also said it is the critical problem that students cannot solve errors themselves at the stage of execution or compilation.

As it seems that programming strongly depends on one’s natural inclinations, Dehnadi et al. insisted that judgment whether a student is good at programming or not is possible in the early stage, before the training of programming, by using relatively simple test [2]. Dehnadi et al. said that the percentage of people with the talent for programming is universal not depending on gender, age, and educational level. Dehnadi et al. also concluded that disposition, not to seek meaning for conclusion as long as thinking is consecutive, is important for programming, and the rate of people who have a talent to enjoy the training of programming is approximately 40 percent.

There are many practices achieving remarkable results. As one of the practices, Tada et al. conducted a research on lecture method which was introduced repetitive study on programming education [3]. This method can effectively memorize frequent patterns in programming for students. This paper considers that entertainment factor is important for education to continue repetitive study. As a practical example of education focusing on the entertainment factor, Komatsu provided a programming education of the basic concept on object-orientation with ActionScript [4]. He showed the effectiveness through the practice of game creation, and notably concluded that the characteristic of ActionScript contributed to an intuitive understanding of programming. Considering these efforts, this paper develops an Internet accessible PLMS which provides an intuitive programming learning function basing on the entertainment factor, and social web functions like SNS.

3 Our Current Work

Right now the authors have taught some programming related subjects for freshmen and sophomores. In the lecture held at first semester of freshman, the basic idea of algorithm, such as description of flowchart, trace of variable value, and the C programming language (from programming syntax to the basic of the array) have been mainly introduced. Subsequently in the lecture held at second semester of freshmen, students have been given the overall idea to interpret and to write the C programming language. Then in the lecture to practice the applied idea of algorithm held at first semester of sophomores, some famous algorithms to seek and to operate data, such as binary search and quick sort, and programming technique to implement these algorithms, have been introduced.

Among these lectures, the first lecture for the introduction of the algorithm is carefully planned to reduce the feelings of resistance toward programming. Concretely speaking, a web based learning game named “Algologic” is used [5]. Algologic is a Web-based software program to learn logical thinking, the fundamental skill to program, with it just like playing games. As a result of using Algologic, a lot of positive feedback was received from questionnaire. However in spite of utilizing Algologic, students who could not catch up with the progression of lecture continued to increase as the lecture went
The achievement test conducted on the final stage showed the existence of many students who could not understand the basic idea of programming at all.

4 Preliminary Investigation and Results

Several tests were conducted in our lecture, and each one's programming skill was objectively evaluated. Also the programming skill and the relation between other factors were examined. Based on the analysis results of the examination, students targeted by our PLMS and functions which should be implemented to the PLMS were clarified.

The lecture of algorithm for sophomores was intended for analysis. The main reason this paper chose the lecture was that the characteristics of students would be relatively noticeable by the previous learning. The other reason this paper chose the lecture was that students targeted by this analysis did not take our lectures, and they were taught by traditional lecture method. In this lecture, there were 55 students. The data used by the analysis is shown below. At first the results of examinations, 12 mini examinations and 2 achievement tests were used, and each test evaluated on a 100-point scale. The questions of each mini examination are based on the content of the previous lectures, so student can solve the exercise as long as he/she fully and correctly understood. On the other hand, the achievement tests include some practical exercises, so students should understand the essence of algorithm and programming. Second, the data about evaluating efforts for the lecture were used: attendance records and submission records of assignments. 12 assignments required to submit, and the submission rate of the assignments were used by the analysis. Additionally, each student's grade point average was referred.

GPA includes a degree of understanding and earnestness for all subjects. To make the value of GPA easy to understand, an index to evaluate earnestness was defined, and it is named as “Score of earnestness”. The score of earnestness was evaluated on a 100-point scale, and was calculated by the average of attendance rate and the submission rate of assignments. The relation between GPA and Score of earnestness is shown in Figure 1. From Figure 1, the cause of GPA under 1.5 is thought to be a lack of earnestness because most students’ score of earnestness with GPA below 1.5 is low. The correlation between GPA and Score of earnestness seems strong from 1.5 to 2.5 of GPA. Most students with GPA over 2.5 have high value of Score of earnestness, so earnestness is thought to be a necessary condition to obtain GPA over 2.5.

Next second index was defined to evaluate programming achievement degree, and it is named as “Score of ability test”. The index was calculated by the average of all tests: 12 mini examinations and 2 achievement tests. The relation between the index and GPA is shown in Figure 2. From Figure 2, we can see relatively strong correlation. The noteworthy point from the result is that there were some students lacking sufficient programming knowledge even they had GPA over 2.5. They are thought not to be interested in programming but earnest, so the authors consider that they will self-study the learn-
ing of programming if they can take an interest because they are earnest.

5 System Development

5.1 Overview of the Proposed System and its Implementation

This paper focuses on students who can self-study but are not interested in programming at this time. A PLMS is developed which enables users to learn programming like game by considering the characteristics of Algologic and by using the functions of Google Blockly [6] and enchant.js [7]. The overview of the proposed system is shown in Figure 3. As above mentioned, Algologic is a puzzle game to learn logical thinking available on the web, and the user aims to automatically lead a robot to the goal point by giving action rule which is constructed with some pieces, each of which corresponds to a certain rule such as moving forward, turn, repetition and branching. Google Blockly is a JavaScript library which can generate JavaScript code visually by assembling some parts corresponding to rules, and the user interface is similar with Algologic. enchant.js is a framework for developing simple games and applications in HTML5 and JavaScript. By combining Google Blockly and enchant.js, an open source library named Maeda Block [8] was developed. This paper uses Maeda Block and Google Blockly Maze to implement visual programming envi-
environment, and provides puzzle based programming questions similar with Algologic. Additionally the proposed system implements a bidirectional communication function like SNS as a new feature. The proposed system runs on a Linux server with Apache 2.2.20, MySQL 5.1.63 and PHP 5.3.6-13. Each user can create, edit, and register the exercise, and challenges an exercise created by another user, and each user can freely post his/her comment for another user and exercises. The exercises are uniquely managed by a database newly developed. With the function of enchant.js, the proposed system is available on Smartphone, and realizes virtual communication between each user through Twitter.

5.2 Evaluation

Evaluation experiment of the proposed system was performed with 16 university and graduate students in informatics as subjects. Before the experiment, attitudes toward programming were firstly surveyed for subjects. The result is summarized in Figure 4 which shows the distribution of subjects for 3 typical questions according to grade. From the distributions of the scores for questions, “programming related subjects” and “programming skill”, the subjects are thought to be a group with intermediate programming skill. With the group of subjects, evaluation results for the proposed system (see Figure 5), for entertainment (see Figure 6), and for the possibility to use introductory education (see Figure 7) were obtained. In each box plot as shown in Figure 5 - 7, the range from 25 percentile to 50 percentile is filled with light blue, and the range from 50 percentile to 75 percentile is filled with dark blue.

Figure 5 shows the evaluation for whole system. The evaluation was diverse because the proposed system was a prototype, but it was found that the user interface needs to be improved. In the question relevant to user interface, it was found that some measures and manuals about Google Blockly need to be prepared because the operation takes getting used to. Figure 6 shows that the entertainment oriented design is relatively positive, but the evidence that students will
positively use the proposed system was not so strong. Some of the subjects said only the form of exercise will be tired. To meet the issue, there were some request to register various types of exercises, for example, competition game and battle game with a monster by using an algorithm. About the function of SNS, there were many feedbacks that the user might not be able to positively learn unless the exercises have a kind of game element such as collection and trade function of some kinds of items (accessories). Figure 6 shows negative feedback for programming training, but positive for logical thinking. A subject commented that the best way to train programming skill is to write a lot of program actually.

6 Conclusion

This paper addressed to support self-study of programming. Firstly to grasp students’ programming skill objectively, the relation between achievement score and GPA was examined by conducting mini tests several times in the lecture of algorithm for sophomores. In relation to this, an index to evaluate earnestness was defined, and the relation between the index and GPA was examined. As the result, it was found that sufficient attendance and submission of assignments are necessary conditions. This paper confirmed the group of students lacking programming skill but earnest, and PLMS was developed for the group. Considering Algologic, the proposed system which can provide exercises of algorithm like puzzle game was designed. From preliminary experimental result, there were many positive feedbacks, but there were some points to be improved. Students who have enough programming skill tended to be negative, on the other hand, students who are not good at programming tended to be positive. The questionnaire result showed entertainment based visual programming environment with social communication capability was efficient, and the target of the proposed system was proper.

Acknowledgment

This work was supported by Japan Society for the Promotion of Science, Grant-in-Aid for Young Scientists (B), No.13304922.

References