Practice and Effects of Programming Education in Blended Quiz Production

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***Abstract*—Blended classes are conducted for the purpose of improving the practices and effects of programming education. Using an environment in which students make quizzes collaboratively or independently, as well as an e-learning system and mutual assessment activity among students, students compose quizzes and evaluate one another in classes. This paper describes differences of consciousness in different performance groups based on the results of a questionnaire administered to students, preferred items for making quizzes, and a comparison of test scores obtained during the first year and second year of Technical College.**

Keywords–programming education; collaborative learning; quiz-making; Moodle

I. INTRODUCTION

Aiming at improving the effects of programming education, each unit was conducted based on blended learning combined with teacher-centered class, individual learning using e-learning and collaborative learning by students' mutual assessment [3]. The results of a questionnaire after finishing all the units and tests revealed that quiz-tests were effective in developing students' knowledge of programming. However, it was found that there were cases when students happened to get correct answers of quiz-tests by guessing.

Therefore, the purpose of this study is to develop an accurate knowledge of students and verify the effect of blended learning after practicing activities of students' making quizzes, which was presumed to be more effective in developing students' understanding of programming than their solving given questions.

Section II explains the collaborative quiz-making environment based on Moodle (Modular object-oriented dynamic learning environment). Section III describes a practical example conducted for unit learning and feedback after practicing each unit. The conclusion of this study and future considerations are expressed in Section IV.

II. COLLABORATIVE QUIZ-MAKING ENVIRONMENT BASED ON MOODLE

The collaborative quiz-making environment module was developed to make multiple-choice questions that can be leveraged with the quiz module as a standard module of the Moodle [3]. The development environment is Moodle 1.9 on Linux server with PHP (Hypertext Preprocessor) 5 script language, MySQL 5 database management system, and Apache 2 hypertext transfer protocol sever [4]. Figure 1 is a use case diagram by UML(Unified Modeling Language) of collaborative quiz-making environment. The collaborative quiz-making environment has the following three functions:

(1) *Students' quiz-making* function

Students can make multiple-choice questions without being aware of the tags needed to make quizzes with Moodle.

(2) *Mutual evaluation among students* function

Through the evaluation items produced by teachers, students can evaluate quizzes made by other students.

(3) *Teachers' quiz-registering* function

Teachers can use the quizzes made by students in quiz modules by registering quizzes made by students into Moodle's standard quiz bank.

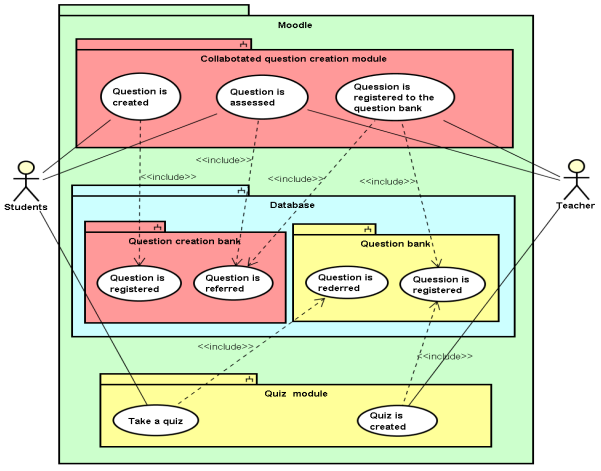

Figure 1. A use case diagram of collaborative quiz-making environment.

III. PRACTICE AND EVALUATION OF CLASSES

Programming education was conducted with a collaborative quiz-making environment for 39 students of the second year of the Electronic Information Department of Technical College. Immediately after one unit of the programming education classes was completed, quiz-making and evaluation activities were conducted. Students were asked to do the activities 3 times in substitution, operation, and input–output, in selection, and in recursion. The quiz to be made included multiple-choice questions for programs of C language grammar. Each student composed a single question and conducted a mutual evaluation for the questions

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with peer students having the same last digit of their student number.

The outline of programming education in blended making quizzes is presented in Figure 2. For each unit, blended classes which consist of individual learning with e-learning quizzes and collaborative learning with the collaborative quiz-making environment were conducted.

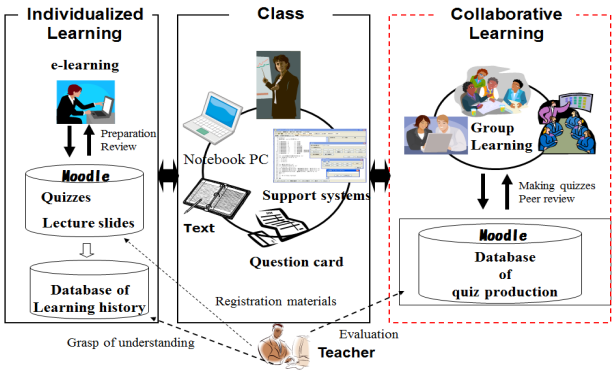

Figure 2. Component of blended classes.

A. *Differences in students' consciousness by performance score group*

After the 30th class, a questionnaire with 45 items related to quiz-making, evaluation, and the collaborative quiz-making environment shown in Table I was administered to 39 students. The questionnaire was administered with the five-level rating evaluation from "5: I think so." to "1: I do not think so". According to the score x of four manuscript tests conducted in 2012, the students were divided into an ascendant group ($x \geq m+SD/2$, 17 students), a median group ($m-SD/2 \leq x < m+SD/2$, 12 students), and a descendant group ($x < m-SD/2$, 10 students), where m and SD respectively denote the average score and standard deviation. For the students answering "3: yes and no" in each group, a significance test was conducted to ascertain whether the average score deviated to the positive side or negative side or did not deviated at all. The result is presented in Table I. The signs of m, SD, t, p, and F in Table I represent the mean, standard deviation, t value, significant probability, and the F value, respectively.

The significance test, conducted for all 45 items, found that each group deviated to the positive side with a significance level of 1%. Additionally, the significance test on each item revealed that the quantities of items which significantly deviated to the positive side in the ascendant group, the median group, and the descendant group were 26, 21, and 29, respectively.

Next, analysis of variance was conducted for each item. The result shown in Table I demonstrates that only the 24th item (The quizzes made by others are difficult.) was significant. As a result of performing multiple comparisons using the LSD (Least Significant Difference) method on the 24th item, a significant difference was found between the ascendant group and the descendant group, suggesting that the students in the descendant group felt that problems made by others were more difficult than those in the ascendant group. The LSD is a method for multiple comparisons after the analysis of variance.

The items that deviated significantly to the positive side suggested the following:

(1) Items that deviated significantly to the positive side irrespective of the score group

The first item and the 20th item showed that students thought it was difficult for them to make quizzes and give advice related to choices (wrong answers). The largest t value in the descendant group was the first item, "making quizzes is difficult," which deviated significantly to the positive side.

The second and fourth items and the 25th and 27th items suggested that students thought that they were able to improve the level of understanding of what they had learned and were able to gain complete control over their knowledge by making quizzes and solving the quizzes made by others.

Moreover, the 40th and 41st items revealed that students were able to accept criticism and advice from others gratefully, which helped them modify their quizzes.

(2) Items that significantly deviated to the positive side were only those of the ascendant group

Only the fifth item deviated significantly to the positive side in the ascendant group, which showed that the students in the ascendant group thought it was more effective to make quizzes than to solve them. For the students in the ascendant group, quiz-making activities might improve the level of understanding of what they have learned.

(3) Items that significantly deviated to the positive side only in the descendant group

The 18th and 19th items showed that the students in the descendant group thought that they were able to improve their motivation for learning and obtain knowledge completely by thinking about alternative choices (wrong answers) for multiple-choice questions. Furthermore, the 23rd item showed that they thought that they could obtain knowledge completely by thinking about advice for wrong answers. Additionally, the 33rd item found that they thought that their use of evaluation activities had improved the level of understanding of what they had learned.

Consequently, although students felt it was difficult to make quizzes, they thought that the activities of thinking about wrong answers and advice and those of evaluation can engender improvement of the level of understanding of what they had learned.

B. *Opinions about making quizzes*

The students were asked to write freely the reasons why they felt it was difficult to make quizzes. The main reasons are shown below:

(1) Benefits of making quizzes

・Making quizzes helps me review what I have learned.

・Making quizzes can improve my understanding of programming.

(2) Shortcomings of making quizzes

・Making quizzes was difficult, so I could not get motivated by myself.

・It took much time to do it.

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(3) Benefits of evaluation activities

・It serves as a review.

・Thanks to this activity, I was able to understand what is important in programming.

(4) Shortcomings of evaluation activities

・I did not know whether I made correct evaluations.

・When I did not understand them, I was unable to make evaluations.

The results of free description suggested that students thought that quiz-making and evaluation activities were able to help them improve their understanding as a review. However, for the students who felt it was difficult to make quizzes alone, they turned out to be demotivating. In addition, some students turned out to feel concerned about making evaluations.

C. *Preferential items of making quizzes*

Asking students to assign the order of priority (1–6) of items on which they placed importance in making quizzes (Table II), a cross table of the result of each item was conducted.

TABLE II. CROSS TABLE OF QUIZ-MAKING PREFERENTIAL ITEMS AND TESULTS OF χ^2 TESTS

Item \ Priority order	Actual frequency							Expected frequency						
	1	2	3	4	5	6	Total	1	2	3	4	5	6	Total
Difficulty level of question	4	9	11	7	7	1	39	6.5	6.5	6.5	6.5	6.5	6.5	39
Option of question (Wrong answer)	1	6	11	12	7	2	39	6.5	6.5	6.5	6.5	6.5	6.5	39
Advisory statement for wrong answe	0	0	0	6	15	18	39	6.5	6.5	6.5	6.5	6.5	6.5	39
Learning contents of question	22	9	3	5	0	0	39	6.5	6.5	6.5	6.5	6.5	6.5	39
Originality of question	3	3	5	4	9	15	39	6.5	6.5	6.5	6.5	6.5	6.5	39
Helpful for learners	9	12	9	5	1	3	39	6.5	6.5	6.5	6.5	6.5	6.5	39
Total	39	39	39	39	39	39	234	39	39	39	39	39	39	234

	Adjusted residual						Significance test					
									*			
Option of question (Wrong answer)	-2.2	-0.2	1.8	2.2	0.2	-1.8			*	**		
Advisory statement for wrong answe	-2.5	-2.5	-2.5	-0.2	3.3	4.5					**	**
Learning contents of question	6.1	1.0	-1.4	-0.6	-2.5	-2.5	**					
Originality of question	-1.4	-1.4	-0.6	-1.0	1.0	3.3						**
Helpful for learners	1.0	2.2	1.0	-0.6	-2.2	-1.4		**				

**: $p < .01$, *: $p < .05$

A χ^2 test was conducted in the 6 × 6 contingency table. Results show that the frequency deviation was significant ($\chi^2(25) = 160.15$, $p<.01$). Then, among the cells in which significant difference was found by residual analysis, the cells with positive residual error were marked with *.

According to the results of residual analysis shown in Table II, students assigned priority to what they learned, and to what was helpful to other students in making quizzes. They did not regard the originality of advice for wrong answers and quizzes as important.

D. *Comparison of test performance between the presence or absence of quiz-making activity*

A regular examination with the same 13 problems was conducted during the 2011 school year, when students did not experience a quiz-making activity, and during the 2012 school year, when they experienced it. The problems are presented in Table III. The problems consist of the multiple-choice questions to test the knowledge of C language, in addition to questions to test the programming ability to make an algorithm and represent it in a C program. In each school year, students solved e-learning quizzes. Each question's average score was analyzed using a significance test. The results are shown in Table IV.

Significant differences were found among the average scores of all 13 questions, showing that the result of the 2012 school year, with quiz-making activity, was higher. Additionally, the SD in 2012 was smaller, so the variation of scores was smaller.

TABLE IV. COMPARISION OF TWO YEARS' TEST SCORES

Category	Question	Perfect Score	2011		2012		Significance Test	
			m	SD	m	SD	t	p
Questions to test C language knowledge	Q.1	16.0	12.5	4.0	11.4	6.2	0.9	
	Q.2	20.0	15.9	5.6	16.6	5.0	0.6	
	Q.3	16.0	11.3	4.4	12.7	4.1	1.5	
	Q.4	12.0	10.0	3.2	10.4	2.5	0.7	
	Q.5	16.0	12.9	4.5	14.7	3.6	2.1	*
	Q.6	12.0	9.6	3.5	10.7	3.0	1.5	
	Average	15.3	12.0	2.8	12.8	2.8	1.2	
Questions to test programming ability	Q.7	20.0	16.6	5.5	16.5	5.9	0.1	
	Q.8	15.0	8.0	6.4	9.9	6.4	1.4	
	Q.9	14.0	11.1	4.7	12.1	3.8	1.1	
	Q.10	15.0	13.3	4.0	14.1	2.6	1.1	
	Q.11	12.0	7.6	4.6	9.8	3.2	2.6	*
	Q.12	10.0	7.3	4.3	8.9	2.9	1.9	
	Q.13	12.0	10.2	3.7	11.1	1.8	1.5	
	Average	14.0	10.6	3.5	11.8	2.3	1.8	
Average score of the whole questions			11.3	3.2	12.3	2.6	2.1	*

*: $p < .05$

With each question's average score, only question 5 to test knowledge (to solve values of variables and pointer variables when programming is conducted) and question 11 to test programming ability (to create a program for a function which assigns an argument value to a 2D array) showed significant difference. The results of the tests suggest that blending quiz-making activities was effective, although only slightly so, for improving programming learning.

IV. CONCLUSION AND FUTURE PROBLEMS

Aiming at improving programming education, class practice was conducted with a blended quiz-making activity using the collaborative quiz-making environment. According to the questionnaire administered after class practice, students, irrespective of performing score groups, reported that quiz-making activities were helpful for their understanding of what they had learned and for making their knowledge complete. At the same time, they thought it was difficult to make quizzes.

The students in the ascendant group thought that making quizzes was more effective than solving them. In contrast, the students in the descendant group thought that thinking about alternative choices led to improved understanding and secured knowledge and that evaluating quizzes made by others improved their own understanding. In making quizzes, students assigned primary importance to what they had learned. They gave secondary emphasis to what was helpful to them. Comparison of the test results obtained during two years revealed that quiz-making activities were helpful, but only slightly, to improve what students had learned and to reinforce their knowledge.

In future studies, several ways to examine should be striven to make students feel it is less difficult to make quizzes, for example by seeking points at issue in their textbook and by reviewing points before quiz-making activities.

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REFERENCES

[1] Y. Fu-Yun, L. Yu-Hsin, and C. Tak-Wai, "A Web-based Learning System for Question-posing and Peer Assessment," Innovation in Education and Teaching International, vol.42, no.4, Nov. 2005, pp.337–348.

[2] A. Nakano, T. Hirashima, and A. Takeuchi, "An Intelligent Learning Environment for Learning by Learning by Problem Posing," IEICE Trans D-I, vol.J83-D-I, no.6, Jun. 2000, pp. 539–549 (in Japanese).

[3] J. Shinkai and I. Miyaji, "Effects of Blended Instruction on C Programming Education," Transactions of Japanese Society for Information and Systems in Education, vol.28, no.2, Apr. 2011, pp.151–162 (in Japanese).

[4] J. Shinkai, Y. Hayase, and I. Miyaji, "Conducting Programming Education Using Collaborative Question-posing Environments," Proceedings of Society for Information Technology & Teacher Education International Conference, Mar. 2013, pp.4742-4747.

TABLE I. COMPARISION OF TWO YEARS' TEST SCORES

No.	Eevaluation Items	(1) Ascendant				(2) Median				(3) Descendant				Distribution of score groups	Multiple comparison by LSD method		
		m	SD	t	p	m	SD	t	p	m	SD	t	p	F	(1) vs. (2)	(2) vs. (3)	(3) vs. (1)
1	Making quizzes is difficult.	3.9	0.8	4.7	**	4.3	1.2	4.0	**	4.4	0.5	8.6	**	1.2			
2	Making quizzes improves understanding of learning contents.	4.0	0.6	6.7	**	4.2	0.9	4.3	**	4.0	0.8	3.9	**	0.2			
3	Making quizzes improves learning motivation.	3.1	0.9	0.5		3.0	1.2	0.0		3.4	0.8	1.5		0.5			
4	Making quizzes makes learning contents complete.	3.9	0.6	6.1	**	4.1	0.8	4.7	**	4.0	0.7	4.7	**	0.3			
5	Making quizzes is more effective for solving quizzes.	3.5	0.7	2.7	*	2.8	1.2	0.5		3.4	1.0	1.3		1.7			
6	Making quizzes is helpful to reviewing learning contents.	3.8	0.9	3.8	**	4.0	0.9	4.1	**	3.8	0.8	3.2	*	0.2			
7	Making quizzes improves program-making ability.	3.9	0.8	4.7	**	4.2	0.9	4.3	**	3.7	1.1	2.1	+	0.7			
8	Making quizzes improves knowledge of programming language grammar.	3.6	0.9	2.9	*	4.2	0.9	4.3	**	4.0	0.9	3.4	**	1.2			
9	Making quizzes improves program knowledge.	3.7	0.8	3.4	**	4.2	0.7	5.6	**	3.9	0.7	3.9	**	1.2			
10	You made quizzes expecting that they would be helpful to other learners.	3.6	1.2	2.0	+	3.6	1.2	1.6		3.4	0.7	1.8		0.1			
11	You made quizzes being aware of what was important in learning.	3.7	0.9	3.2	**	3.5	0.9	1.9	+	3.8	0.9	2.8	*	0.3			
12	You made quizzes being aware of intention of giving quizzes.	3.4	1.0	1.5		3.6	0.9	2.2	*	3.6	0.7	2.7	*	0.3			
13	You can not make quizzes from matters that I do not understand.	4.2	1.0	5.3	**	4.7	0.7	8.9	**	4.1	1.4	2.5	*	1.0			
14	You studied in advance to make quizzes.	2.8	1.1	0.8		3.5	1.2	1.4		3.2	0.9	0.7		1.6			
15	You had a talk with other learners to make question.s	3.4	1.2	1.2		3.2	1.0	0.6		3.3	1.1	0.9		0.1			
16	Thinking about choices (wrong answers) is difficult.	3.6	1.0	2.4	*	3.3	1.4	0.8		4.0	0.8	3.9	**	1.0			
17	Thinking about choices (wrong answers) improves understanding of learning contents.	3.5	1.1	2.0	+	3.6	1.1	1.9	+	3.4	0.7	1.8		0.9			
18	Thinking about choices (wrong answers) improves learners' motivation.	2.9	0.9	0.3		2.9	1.3	0.2		3.5	0.5	3.0	*	1.3			
19	Thinking about choices (wrong answers) makes the knowledge of learning content secure.	3.3	1.2	1.0		3.1	1.2	0.2		3.6	0.7	2.7	*	0.6			
20	Thinking of advice for choices (wrong answers) is difficult.	4.1	0.9	4.9	**	4.3	0.9	5.0	**	4.1	0.7	4.7	**	0.2			
21	Thinking of advice for choices (wrong answers) improves understanding of learning content.	3.8	0.9	3.8	**	3.6	1.0	2.0	+	3.5	0.7	2.2	+	0.5			
22	Thinking of advice for choices (wrong answers) improves learners' motivation.	2.9	0.9	0.5		2.7	1.4	0.8		3.1	0.6	0.6		0.5			
23	Thinking of advice for choices (wrong answers) makes the knowledge of learning contents secure.	3.5	1.1	1.7		3.5	1.4	1.3		3.6	0.7	2.7	*	0.0			
24	Quizzes made by others are difficult.	3.1	0.7	0.4		3.7	0.9	2.6	*	3.9	0.6	5.0	**	5.0 *			*
25	Solving quizzes produced by others improves understanding of learning content.	3.9	0.8	4.7	**	4.6	0.5	10.7	**	4.1	0.7	4.7	**	2.9			
26	Solving quizzes made by others improves learners' motivation.	3.4	1.0	1.7		3.8	1.1	2.3	*	3.9	0.9	3.3	**	0.8			
27	Solving quizzes made by others makes the knowledge of learning contents secure.	3.8	0.8	4.2	**	4.2	0.8	4.8	**	4.2	0.8	4.8	**	1.4			
28	Quizzes made by others make you aware of what is important in learning.	3.5	0.9	2.5	*	4.0	0.6	5.7	**	3.8	0.6	4.0	**	1.5			
29	Blanks in quizzes made by others are appropriate.	3.6	0.8	3.0	**	3.9	0.7	4.7	**	3.8	0.6	4.0	**	0.8			
30	Wrong answers made by others are appropriate.	3.6	0.8	3.4	**	3.7	0.9	2.6	*	4.0	0.8	3.9	**	0.7			
31	Advice for wrong answers made by others is appropriate.	3.5	0.7	3.0	**	3.5	0.9	1.9	+	3.6	0.5	3.7	**	0.1			
32	Evaluating quizzes made by others is difficult.	4.2	0.8	6.0	**	3.6	1.0	2.0	+	3.8	0.4	6.0	**	2.0			
33	Evaluating quizzes made by others improves understanding learning contents.	3.2	1.3	0.6		3.3	1.2	1.0		3.9	0.7	3.9	**	1.3			
34	Evaluating quizzes made by others improves learners' motivation.	2.7	1.0	1.2		3.4	1.1	1.3		3.6	1.2	1.6		2.7			
35	Evaluating quizzes made by others is helpful to review learning contents.	3.6	0.8	3.0	**	3.6	1.1	1.9	+	3.8	0.8	3.2	*	0.2			
36	Evaluating quizzes made by others improves program-making ability.	3.0	0.9	0.0		3.2	1.2	0.5		3.4	0.8	1.5		0.5			
37	Evaluating quizzes made by others improves the knowledge program language's grammar.	3.4	0.8	1.9	+	3.5	1.1	1.6		3.6	1.1	1.8		0.2			
38	Evaluating quizzes made by others improves program knowledge.	3.4	0.8	2.1	*	3.8	0.8	3.5	**	3.7	1.1	2.1	+	0.9			
39	Evaluations made by others are appropriate.	3.8	0.7	4.7	**	3.8	0.9	3.0	*	3.6	0.7	2.7	*	0.3			
40	You can accept evaluations made by others gratefully.	3.8	1.0	3.3	**	4.1	0.7	5.6	**	3.9	0.7	3.9	**	0.3			
41	Evaluations made by others help you to modify your questions.	4.0	0.9	4.8	**	4.3	0.6	7.0	**	4.2	0.6	6.0	**	0.5			
42	Evaluations made by others help you to modify your questions.	3.6	0.9	2.8	*	3.4	0.9	1.6		4.0	0.7	4.7	**	1.4			
43	The system's quiz-making function is easy to use.	2.8	1.0	0.9		3.1	1.0	0.3		3.4	1.2	1.1		1.2			
44	The system's evaluation function is easy to use.	3.0	1.0	0.0		3.3	0.9	1.3		3.6	0.8	2.3	+	1.4			
45	The system's evaluation browsing function is easy to use.	3.1	1.2	0.2		3.3	1.1	0.8		3.4	0.7	1.8		0.3			
	Average	3.5	0.5	4.3	**	3.7	0.5	4.8	**	3.7	0.5	4.9	**	0.7			

**: $p < .01$, *: $p < .05$, +: $p < .1$

TABLE III. EXAM QUESTIONS

Questions to test C language knowledge	Q.1	Fill in the blanks of algorithm to obtain product power of odds from one to n.
	Q.2	Input integer number data and fill in the blanks of the program to obtain absolute figure abs of the value.
	Q.3	Input n unknowns of data with the keyboard and store them into array a[]. Then fill in the blanks the program to obtain the maximum value amax of the data.
	Q.4	Fill in the blanks of the algorithm to obtain nth multinominal using Horner's method.
	Q.5	Write the value when the following program is conducted (pointer variable).
	Q.6	Fill in the blanks of the program of function DelBlk (), which stores the sequence of blanks in the array s[] as a single blank into the array t[].
Questions to test programming ability	Q.7	Make a program to obtain greatest common division gcd of two natural numbers a and b using the Euclidean algorithm.
	Q.8	Make a program that presents when it is prime number and when it is not when a positive integer n (n>1) is input.
	Q.9	Make a program of function sum () to obtain the sum of integer n to m. Then, n and m are arguments.
	Q.10	Make a program of the function abs_fun() to obtain absolute values of integer data x of arguments.
	Q.11	Make a program of the function fun() to input integer data z in all factors of the nth row and the mth column in integer type 2D array x[N][M] .
	Q.12	Make a program using the function strleng() to the length of the array of arguments.
	Q.13	Make a program using the function swap to interchange the values of integer a and b.

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