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Development and Evaluation of Teaching Programming Skills at Tertiary Level using Tutoring System

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ABSTRACT

Learning how to program is a common problem faced by many students in introductory programming courses. The difficulty of introductory such as teaching programming has confronted educators for decades many suggested strategies for improving the teaching process, individual tutoring has proven to be instrumental. The objectives of this study are (1) to develop the system based on programming skills, (2) to identify the programming difficulty of students (3) Significant difference between control and experimental in terms of problem-solving. The control and experimental group composed of 50 students were used in the study. Pre-test and post-test results were analyzed using standard deviation and statistical correlation. The results of mean scores and standard deviation show that there is a significant difference between the control and experimental group. Correlation results show no significant relation. Data from diagnostic and post-assessment is a highly significant difference based on academic performance, skill acquisition, and problem-solving skills. The experimental group performs better, an indication that the intelligent tutoring system with remediation is better than the control group. As a result, the tutoring system helps the students while doing tactual programming.

Keywords: Programming Skills, Problem-Solving, Tutoring System

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INTRODUCTION

The difficulty of introductory such as teaching programming has confronted. educators for decades many suggested strategies for improving the teaching process, individual tutoring has proven to be instrumental. Since teachers have a limited amount of time to help students, user-friendly, automated instructional material would be a great benefit to students. Tutoring System is a natural solution to this need, as it is intended to give individual feedback and support to students who are working on problems.

The significant impact in various areas of life in solving complex problems that would necessitate immense human expertise. It stimulates the individual's reasoning process by using human knowledge and interfaces to solve problems that usually would require human intelligence. The traditional education system can transform the expert systems in the fields. Such as identifying training for teachers assessing needs to teach information and skills using computer-assisted instruction. Intelligent tutoring systems that will guide students to learn through instruction depending on their strengths and weaknesses.

The difficulties in programming evolved from issues such as IDEs are troublesome, misunderstanding of memory operations, abstract nature without a proper foundation in programming, and misconceptions between a class and an object. The students, potential learning difficulties encountered in learning in C# programming is the issue concerning Class-Object and the relationship between them. An identified potential problem of student self-assessment about learning C# programming cannot understand the operation within the computer when it executes a program such as a lack of knowledge about memory operations. Besides, insufficient proper helping tools and reference materials; and difficulties in reading someone else code, testing and debugging applications, and detecting logic errors.

OBJECTIVES OF THE STUDY

The aims of this study are (1) to develop the system based on programming skills, (2) to identify the programming difficulty of students (3) Significant difference between control and experimental in terms of problem-solving.

MATERIALS AND METHODS

To evaluate the effectiveness and usefulness of the system to be developed, an evaluation and testing plan were devised. These will guide the researcher in evaluating the functionality of the Tutoring System in its final phase. Based on the Tutoring System architecture usually reported in the literature, the researcher summarizes the four components of the module in the providing of trendy instruction to the individual student

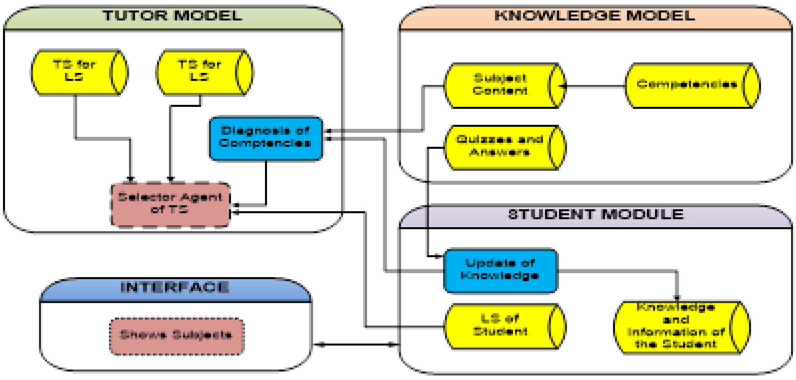

Figure 1. The Four Components of Architecture of Tutoring System

Knowledge Model

This paradigm is sometimes referred to as an expert domain or expert knowledge module in certain tutoring systems. It reflects the declarative and procedural information that the creator wants students to acquire, such as concepts, subjects, rules, logical assertions, and question banks. In general, a knowledge model incorporates domain-specific information that was obtained from the expert. A knowledge domain acts as a benchmark against which students' knowledge and performance throughout the learning process may be evaluated, as well as a source of learning objectives. As a result, issue solutions are developed in an environment that students are familiar with, and their efforts toward resolution are compared to the norm. Additionally, the knowledge module identifies multiple solution approaches and assessment criteria for assessing student response variability.

Student Model

This approach captures students' most recent level of knowledge. It includes the qualities of students' learning and actively evaluates students' transformation during education. Students' cognitive knowledge, test scores, learning preferences, and active, metacognitive, and learning behaviors are all significant components of their education. These are the critical components that allow Tutoring System to comprehend a student to a certain degree, similar to a human tutor, and to provide an appropriate education.

Tutor Model

In certain ITSs, a tutoring model is referred to as a pedagogical model. It provides individualized instruction and arranges learning material for pupils. Nonetheless, monitoring students' progress and customizing education to their needs are critical characteristics of ITSs that set them apart from other kinds of CAI systems. To provide the most suitable education for each student in each learning experience, it is necessary to properly represent the students' current level of knowledge, diagnose the fundamental reasons for their mistakes, and provide tailored support to those encountering trouble.

User Interface Module

An Intelligent Tutoring System's interface module serves as the "front-end" component. Through the presentation of pertinent information to students and the gathering of their inputs, the interface module allows communication and interaction between the system and students. Additionally, it supports students in navigating the system and provides educational replies and feedback gleaned from the tutor model. Students may work at their speed and get advice on how to customize their learning based on the nature of their viewpoints.

This research discusses a hybrid approach to learning that incorporates both online and conventional face-to-face instruction. Pupils study new ideas independently over the internet, while instructors assist students who need further assistance. As a consequence, instructors may concentrate their efforts in the classroom on instructing pupils on how to overcome their learning obstacles and develop their higher-order abilities. This hybrid technique has been implemented in several university courses since it promotes active learning among students. It incorporates the best features of conventional face-to-face education with learning management systems. The Learning Management System (LMS) is a hybrid environment for learning that includes offline and online components. The offline environment encompasses both the inside and outside of the classroom/laboratory where face-to-face teaching and learning occur.

The experimental design for this research was a pre-and post-test control group. Table 1 summarizes the design of this investigation. To determine the efficiency of tutoring systems in assisting students with their learning difficulties, this research utilizes dependent variables that comprise two distinct delivery methods: an online tutoring system and face-to-face lectures. Students' perceptions about programming are the dependent variable. Last September 23 to 24, 2018, the researcher did an assessment. On September 23rd, the researcher administered to 50 BSIT third-year students who served as the control group, and another 50 BSIT third-year students who served as the experimental group on September 24th. Both groups were randomly allocated, as were those who registered in the aforementioned course. The experimental group and the control group are shown in Table 1. (R). Before the trial began, both groups completed a pre-test (O1). The two groups then participated in a two-hour face-to-face seminar. The pupils were expected to sit through a whole classroom lecture throughout the course's lesson. The researcher supervised the whole procedure to ensure that students stayed on track. After both groups had mastered the courseware material, the experimental group received therapy in the form of tutoring sessions.

The control group, on the other hand, continued their education by completing the course's exercise and exam parts. Both sets of students completed a post-test after their therapy (O2). These are the groups; the experimental group is designated as the X group, while the control group receives face-to-face instruction. A pre-test on programming was performed to adjust for individual differences before the experiment.

Table 1. Experimental Design of the Study

Experimental	R	O_1	X	O_2
Control	R	O_1		O_2

The purpose of this research is to determine the impact of implementing the environment and educational activities. The following steps are taken:

Step 1: Prior to the course, determine the desirable features of the learner (pre-test).

Step 2: Setup consists of the classroom atmosphere and instructional equipment. This study analyzed an experimentally created model with a total of 100 BSIT students enrolled in the Information Technology course at Pangasinan State University, San Carlos Campus. By random selection, the students were divided into two groups: 50 BSIT students in the experiment group and 50 BSIT students in the control group.

Step 3: Conduct instruction and learning. The experiment group received instruction using the created model, whereas the control group received instruction using the conventional face-to-face manner.

Step 4: Evaluate the students' proficiency after the course (post-test). Following the session, both groups were evaluated using the same inspection tools.

Step 5: Analyze the data. The examination findings were examined statistically using the mean score, standard deviation, and t-test.

RESULTS AND DISCUSSION

The researcher summarized the encountered difficulty during the assessment. Table 2 depicted the list of student difficulties of fifty (50) BSIT students based on random selection, which represents the experimental group, who took up the assessment exam from 1 to 5. This study revealed that student difficulties such as keyword mistype, an undeclared variable, operator misuse, data type misuse, and unhandled exception were detected.

Table 2. Summary of Students' Difficulty

No. of Students	Keyword Mistype	Undeclared Variable	Operator Misuse	Data type Misuse	Runtime Error	Unhandled Exception
1	11	6	6	5	0	0
2	5	5	3	0	0	0
3	15	6	0	4	0	0
4	6	6	4	3	0	0
5	8	1	3	4	0	0
6	8	0	7	4	0	0
7	13	1	3	1	0	0
8	8	4	6	5	0	0
9	8	6	3	3	0	0
10	14	2	7	0	0	0
11	10	0	8	2	0	0
12	5	1	5	1	0	0
13	10	2	2	3	0	0
14	8	3	7	3	0	0
15	6	0	2	2	0	0
16	9	0	0	0	0	0
17	7	2	8	4	0	0
18	1	6	2	4	0	0
19	13	0	4	1	0	0
20	7	4	5	4	0	0

21	9	0	0	1	0	0
22	9	4	1	7	0	0
23	9	0	9	1	0	0
24	6	0	3	2	0	0
25	6	4	3	3	0	0
26	6	4	6	7	0	0
27	7	0	2	1	0	0
28	5	4	0	2	0	0
29	7	0	9	4	0	0
30	7	4	4	2	0	0
31	7	1	2	2	0	0
32	8	4	2	2	0	0
33	8	1	0	2	0	0
34	7	3	0	4	3	0
35	11	4	7	0	3	0
36	5	4	5	0	0	0
37	13	2	2	9	0	0
38	11	5	0	5	0	0
39	8	2	0	2	0	0
40	14	8	2	1	0	0
41	8	9	3	1	0	0
42	10	4	2	1	0	0

43	7	4	5	4	0	0
44	4	2	3	1	0	0
45	14	2	2	0	0	0
46	2	3	2	1	0	0
47	11	3	3	0	0	0
48	13	2	3	0	0	0
49	8	2	0	3	0	0
50	13	6	4	0	0	0

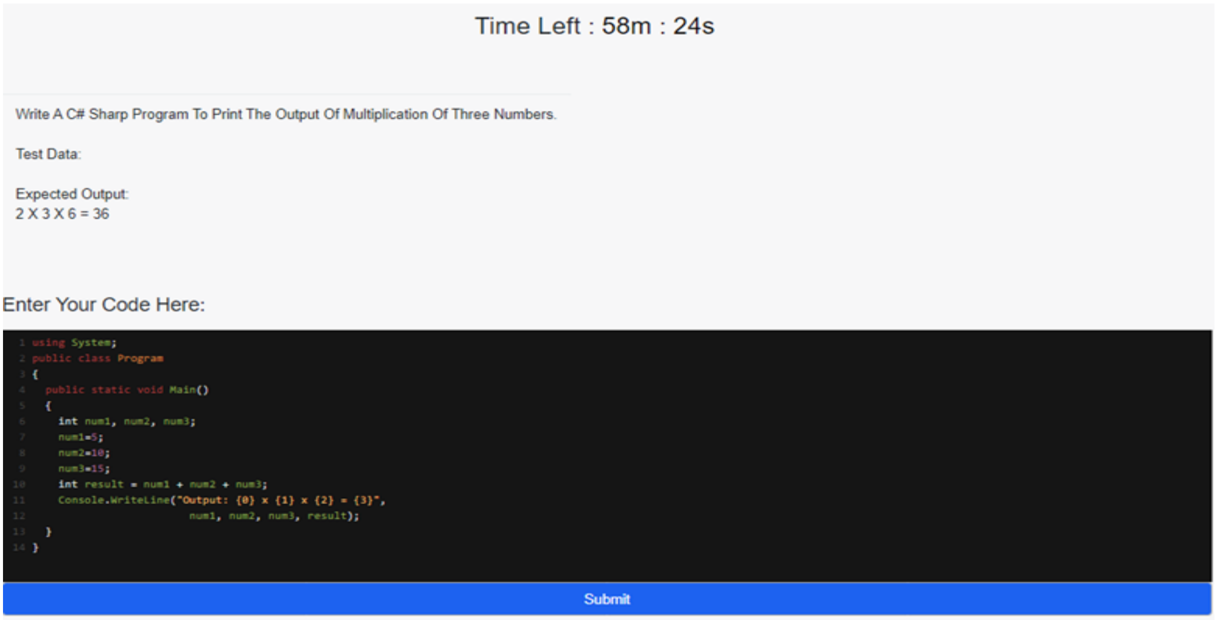

Figure 2. Program submission with errors

Similarly, the example was given the grade of the student was 70, with a score of 4, which was the system detected that the answer was wrong and no error in the program. Based on the set rule and with the given score was lesser than 5.

The following explains the score and rule.

Where score:

4 – The answer was wrong without an error

1 – The answer was wrong with an error

Applying the formula:

if P(D)>0 && score<5 then

Rating = score/(item)*50+50

= 4/10*50+50

Rating=70

Figure 2 explained the program submission with errors. The wrong answer means the program finished within the time limit, and the answer produced was incorrect. This error was the most frustrating part for the students in the coding program as, typically, no extra information was given. According to Kattis (2017), the submitted code with no error was the only way around finding bugs in the code by constructing tricky test data in the program. On the one hand, one of the examples was the output limit that produced too many outputs or "infinite" ones. Also, some codes submitted which were simulated to the compiler had an error.

Tables 3, shows the summary of control and experimental assessment results of problem-solving and presented below the diagnostic assessment from the control group. The researcher was administered 50 BSIT students who took up the traditional. However, another 50 BSIT students from the experimental group utilized the developed system. The comparison of the mean between the control and experimental groups is revealed in Table 6.

Table 3. Summary of Grades Control and Experimental Group

No. of Students	Diagnostic 1-5					No. of Students	Assessment 1-5				
1	75	75	70	75	75	51	80	80	75	100	100
2	75	75	70	75	75	52	90	80	75	100	100
3	75	75	70	75	75	53	90	80	75	100	90
4	70	75	70	75	75	54	90	90	75	100	90
5	70	75	75	75	75	55	90	90	75	100	90
6	70	75	75	75	75	56	100	90	80	90	100
7	70	70	75	75	70	57	100	90	80	90	100
8	70	70	75	70	70	58	100	80	80	90	100
9	70	70	75	70	70	59	100	90	90	90	100
10	70	70	75	70	70	60	90	90	90	100	90
11	75	55	75	70	55	61	90	80	100	100	90
12	75	70	55	75	55	62	100	80	75	100	90
13	70	70	55	75	55	63	100	90	80	100	80
14	70	70	55	75	55	64	90	90	80	90	80
15	70	55	75	75	75	65	90	90	80	90	80
16	70	55	75	55	75	66	90	80	75	90	80
17	70	55	75	55	75	67	100	90	75	90	75
18	70	90	75	55	80	68	100	80	90	80	75
19	70	70	70	55	80	69	90	90	90	80	75
20	70	70	70	75	80	70	90	80	90	80	75
21	70	70	70	75	80	71	90	90	100	75	100
22	70	55	70	75	75	72	80	100	100	75	90
23	70	55	70	70	70	73	80	100	90	75	90
24	70	70	55	70	75	74	100	90	90	80	90
25	55	70	75	70	70	75	80	90	90	75	70

26	70	70	70	70	75	76	80	100	90	80	100
27	55	70	75	75	70	77	80	100	100	90	80
28	55	70	70	75	80	78	80	90	100	90	80
29	55	75	75	55	80	79	100	90	100	90	80
30	70	75	80	55	80	80	100	100	90	100	75
31	80	75	80	55	70	81	90	100	90	100	80
32	75	75	80	55	70	82	90	80	90	90	75
33	75	70	90	80	75	83	100	90	90	90	80
34	75	70	70	80	75	84	100	90	100	80	90
35	75	70	70	80	75	85	90	80	100	90	90
36	75	70	70	80	75	86	90	90	90	80	90
37	75	80	70	80	70	87	90	90	90	90	90
38	70	80	75	80	70	88	100	90	90	80	100
39	70	80	75	80	70	89	100	80	90	75	80
40	70	80	70	75	55	90	100	100	100	75	80
41	70	70	75	75	55	91	90	100	100	75	80
42	70	70	70	75	55	92	90	100	100	100	75
43	55	70	75	70	55	93	90	100	90	80	80
44	55	55	70	70	70	94	100	80	90	80	75
45	55	80	75	70	70	95	100	80	80	80	75
46	55	80	70	55	75	96	90	80	90	75	80
47	55	80	75	55	70	97	100	90	90	100	75

48	55	55	55	55	75	98	100	90	80	100	80
49	55	55	55	55	70	99	90	90	80	90	90
50	55	55	55	55	80	100	90	75	75	90	90
Control Group						**Experimental Group**					

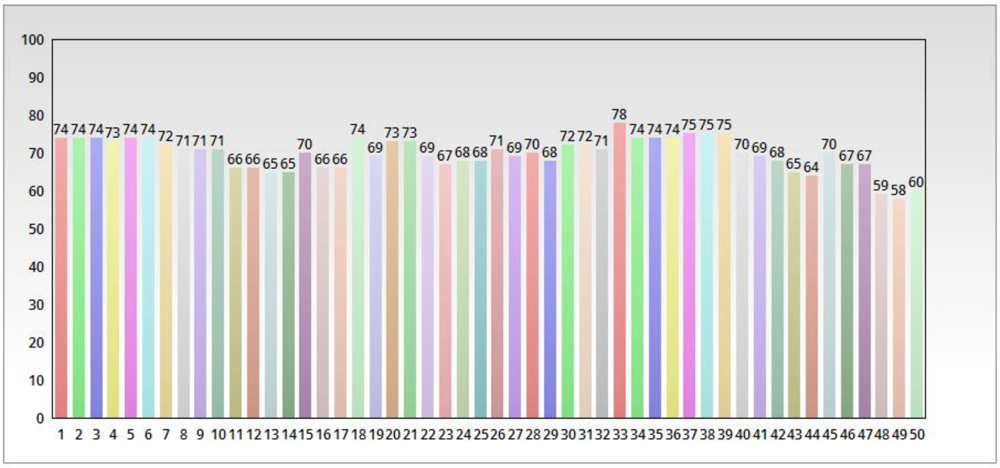

Figure 3. Control Group

Figure 3 presented the results of the control group; on the average rating, most of the students got a lower score. Therefore, it revealed that there is a significant difference between the two groups.

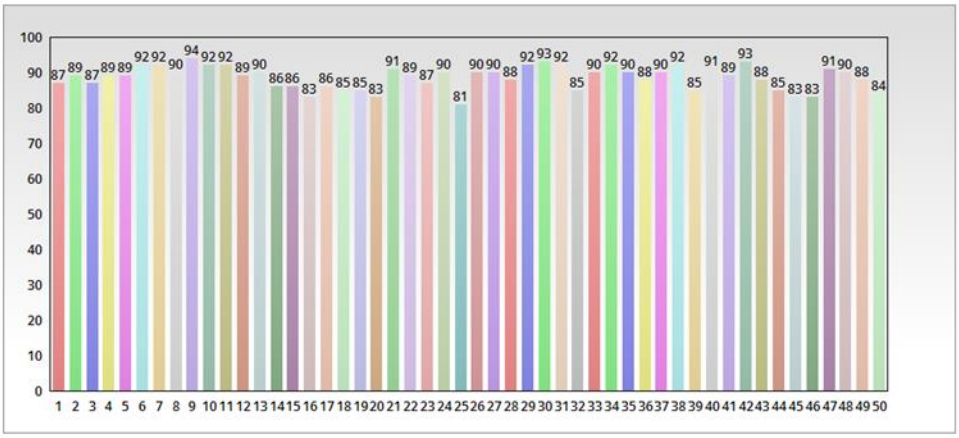

Figure 4. Experimental Group

Figure 4 illustrated the experimental group, the average rating presented in a graph showing that there is a significant increase in the experimental group than the control group.

Table 4. Mean Score and Standard Deviation of Control and Experimental Group

Variable	Control Group Pre-test		Experimental Group Post Test	
	Mean	S.D.	Mean	S.D.
Problem Solving	69.76	4.31	88.52	3.18

Table 4 shows the mean scores and standard deviation of academic performance, skill acquisition, and problem-solving from the control and experimental group. The variables of the t-test analysis between the two (2) groups were completed. The significant difference between both groups' obtained data and statistical calculations is shown in Table 5.

Table 5. Correlation between the Control and Experimental Group

Variables	Correlations	Groups	Degree of Relationship
3. Problem Solving	Correlation	0.213	Low
	Sig.	0.137	

**. Correlation is significant at the 0.05 level (2-tailed).

Table 6 revealed the comparison of the results of the control group and the experimental group. The comparison and significance at the 0.05 level (2-tailed). Furthermore, the results indicated that there is a highly significant difference between the control group and the experimental group in terms of academic performance, skill acquisition, and problem-solving. The assessment was tested and proven using paired t-test statistical treatment.

Table 6. Comparison of the Mean between the Control and Experimental Group

Variables	Groups	Mean	Mean Difference	T	Sig. (2-tailed)
3. Problem Solving	Control	69.760	-18.760	-27.76	0.000**
	Experimental	88.5200			

**. Significant at the 0.05 level (2-tailed).

CONCLUSION

The following conclusions were formed considering the findings:

1. The system will support the student's difficulty.
2. The system architecture and prototype will evaluate the designers in developing the tutoring system.

The results indicate that the system was evaluated and found to be beneficial for the respondents.

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