The Impact of an Intelligent Tutoring System in Programming: A Case Study in Improving Academic Performance of Student in Tertiary Education

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***Abstract* - The Philippine education system's problem is the increasing number of growing students similar to the global population growth. These compel lecturers utilized a computer program that represents the information and provides interaction with students like the Intelligent Tutoring System whose instructional aims are aligned to the academic usefulness toward students having different levels, capabilities and interests. The objective of this study is to investigate the impact of Intelligent Tutoring System in the students' academic performance and, determine the significant difference among the control and experimental group in terms of academic performance, analytical skills, problem-solving and perceived use of the portal. The performance assessment which served as data collection tool was administered for both the control and experimental group. Data obtained from the control and experimental groups were analyzed to test the research hypotheses. Results of the analysis revealed that there is significant difference between the experimental groups. The arithmetic means derived from the experimental group, the one that received instruction through the Intelligent Tutoring System, affect the academic performance. Based on the findings, the performance level of the experimental group was greater than that of the control group.**

Keywords - Intelligent Tutoring System; Programming; Academic Performance; Tertiary Education

I. INTRODUCTION

Intelligent Tutoring Systems (ITS) are computer programs utilizing instructional technologies and artificial intelligence that know what, whom, and how to teach [1]. Moreover, the study states that a well-defined ITS is a computer program that represents the information and provides interaction with students with the utilization of artificial intelligence techniques [3, 10]. Various applications with the aid of computers are being applied already in the delivery of instruction which have played very important role in the teaching and learning processes. Since information technology has been essential in the development of advanced countries, its fast development has supported the reality that information groups are required to adopt and follow the technological development in order to sustain their present Intelligent Tutoring Systems [4].

One of the Philippine education system's most serious problems is the increasing number of growing students similar to the global population growth that teachers are obliged to apply a method using a computer-aided software whose instructional aims are aligned to the traditional teaching strategies and presented toward students having different levels, capabilities and interests. In this method, Intelligent Tutoring System cannot be validated due to some problems such as feedback from the users and absence of assessments in determining the weaknesses and strengths of the students. Thus results of researches completed to solve these problems of coming up with the idea of developing artificial intelligence models in which teaching role is undertaken through the use of computer, and learning activities which are implemented in an interactive way, have gained wide acceptance.

Various factors have influenced the students' academic performance such as age, gender, social background, residential area, economic status of students, a medium of instruction, etc. In return, this affects the attainment of the objectives of any newly created programs in universities. The fast growing application of artificial intelligence in higher education systems has been perceived, supported by the fact that it helps academic institutions to learn new, interesting and useful knowledge about students [5].

Moreover, they compared traditional computer-aided teaching systems with intelligent tutoring systems. It was revealed that ITS lessens learning period by 30% [5] and improves the quality of learning by 43%. It was established one of the primary causes of the enhanced excellence learning is the change to micro education, student focus and the adjustment of the teaching strategy conferring to the skill level and ability of the students in the learning method.

Several studies conducted and many educational software were develop that sought for the effectiveness of information provided to students. Those evaluated and direct the students with the support of computers that directed to the new research area called Computer Assisted Instruction (CAI). CAI is one of the and reinforcing the gained behavior with computers [14]

A web-based Intelligent Tutoring System developed comprises of information subject, which students have to know user interface mechanism leading to students modeling unit and interact with students. Python, PHP and Java Script were utilize for the design, the database and coding of the user interface respectively. Figure 1 shows System Architecture.

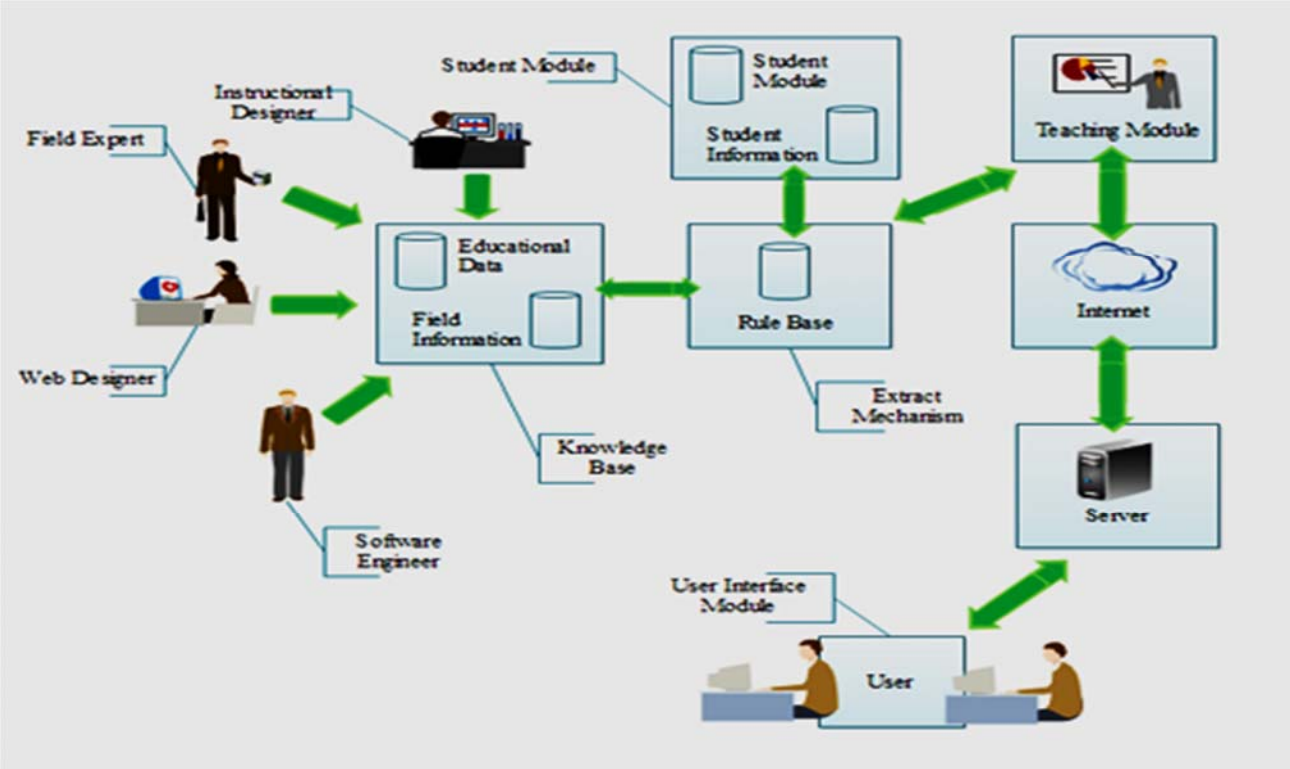

Figure 1. Architecture Structure of System

First step is for the students to join the system by providing information corresponding first and last name, username, password, department. In the next step, students link to the system with their own password and username. Students will undergo a test to assess their level of knowledge on the subject matter. The result of the test will be the basis to create the student model. The created student model will record the test result of students and send to the page in accordance with the pre-built student subject model or generated content. The activated system enables the students to undergo different assessment at the end of the unit test and study first all subjects in the unit. If the student's model displays success at the end of the unit test, evaluation of students are elevated to a higher unit and directed to the relevant topics. If ever the students failed in the unit assessment test, the system will directs the student to a linked topic in order to eliminate the deficiencies. Each subject test scores is calculated and recorded. Figure 2 on next page shows the Students' Model Flowchart of the System.

The subject page shows the subject units in one screen in student's model. This page derives the knowledge level of students based on their answers in placement test. It points out the questions answered correctly and accurately as well as the questions answered incorrectly and all other issues to assess the level of information in academic assessment. The sample subject page shown in Figure 3, see next page.

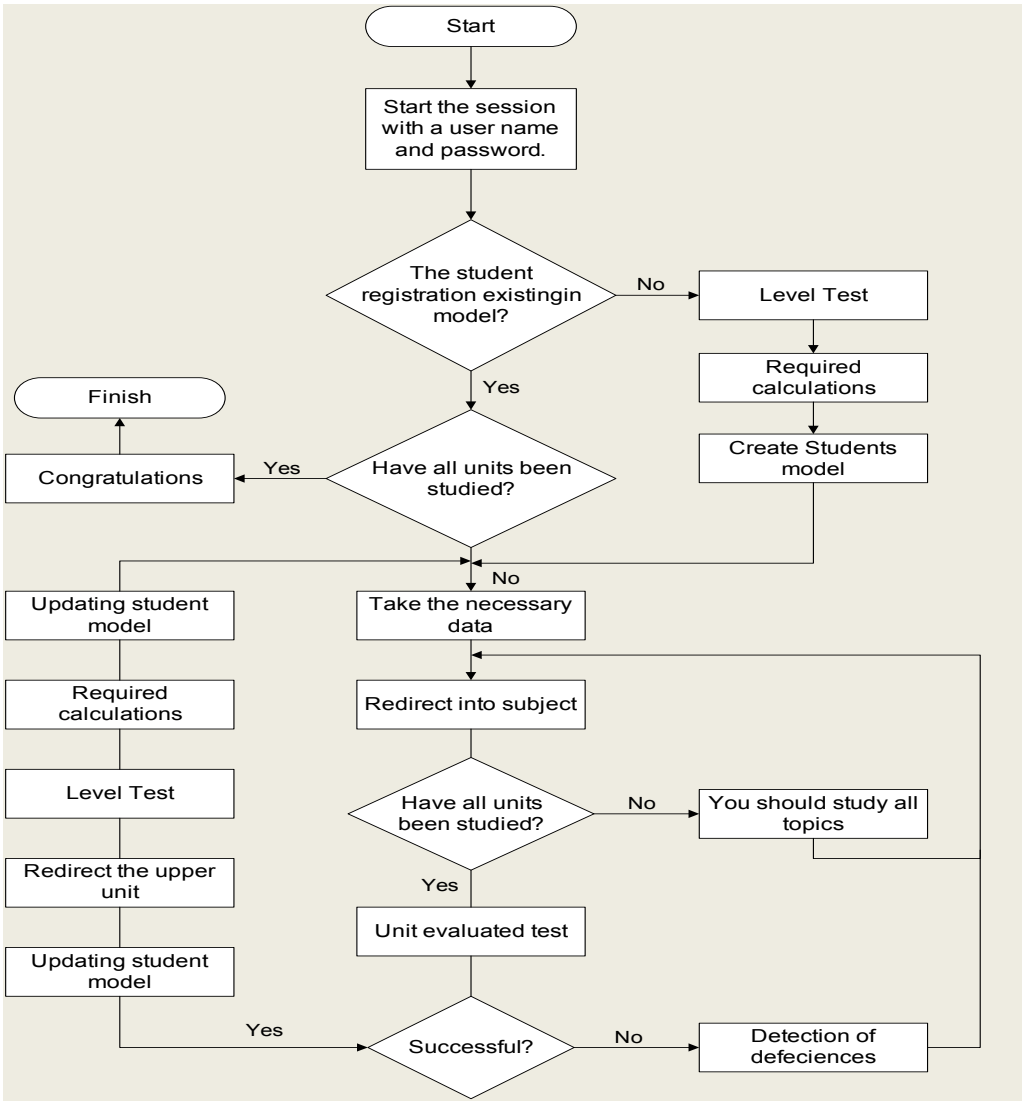

Figure 2. Students' Model Flowchart

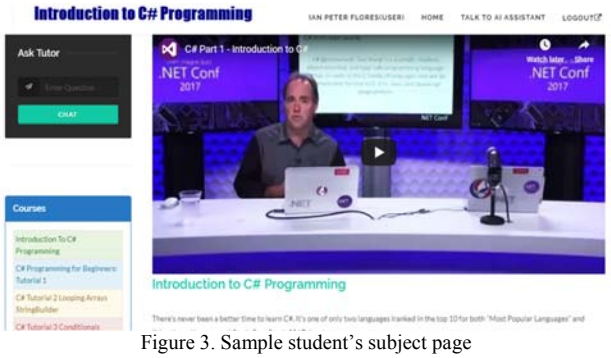

Figure 3. Sample student's subject page

The process of a newly designed model as discussed in the lecture on Introduction to C# Programming wherein the students derive instruction from the model that is more effective. The model aimed to increase the interest of the students to the lecture and motivate them to enhance their academic performance through evaluation of their needs and wishes during the process. The study investigated the model's effectiveness on the academic performance of students. Figure 4 shows this model.

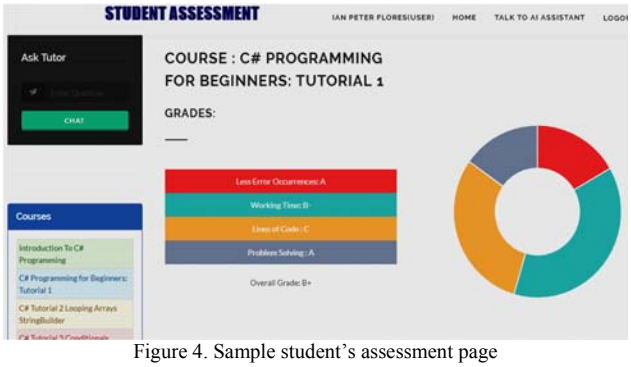

Figure 4. Sample student's assessment page

The objectives of this study are to investigate the impact of Intelligent Tutoring System in the students' academic performance and to determine the significant difference between the control group and experimental group in terms of academic performance score, analytical skills, problem-solving and perceived use of the portal.

II. RELATED WORKS

A similar four module Intelligent Tutoring System Architecture was proposed which allows interaction with students through an interface module and data collection for modifying and customizing instructional assistance [1]. The developed Intelligent Tutoring System using ITSB authoring tool is capable of helping the student make the learning process more enjoyable and to learn how to program well. A knowledge based Intelligent Tutoring System Based (ITSB) tool was also utilized to exemplify the effort of student and to give personalized feedback and assistance toward students [8]. The quality of interactions between learners and tutors effects the quality of learners and quantity responses when answering questions using mixed-initiative dialogues thus learning performance are affected [13].

There are two factors affecting students' performance. These are the intellectual and non-intellectual with emphasis on the best measure, which is the intellectual abilities. The grounds of poor academic performance are classified into four namely, residents in the family, in the student, in the school, and in the society. Furthermore, the influence of teaching on student's achievement test in learning Algebra and the used the regression analysis to find the major factor affecting learning Algebra, the used of data to evaluate the factors affecting their later achievements [5, 7].

Furthermore, the study recommended a system to universities in Thailand to catch possible correlations between the student's historical records and results and used Neural Networks hoping that the experts will recommend the suitable courses for students to increase their chance of passing. Moreover, the used artificial neural networks to predict students' performance in Lyceum University in Greece. Two Hundred Seventy-Nine sample data in Mathematics were trained using a neural network, which illustrated a better classification result than the classic statistic ones [5, 6].

The build model using a linear regression correlation to compare final grade and social background of 100 samples collected at the Islamic University in Pakistan [10]. In addition the used data mining technique to predict the performance of students in an international program in Thailand which focused on the following variables; number of working hours for students, marital status and the number of the courses registered per student [8].

III. METHODOLOGY

The researchers employ experimental approach wherein the data were collected and evaluated to identify if there is a significant difference between the control and experimental group of the respondents in terms of academic performance, perceived use of the portal, analytical skills and problem-solving. The ability of the learner to succeed covariates are analyzed and the experimental group is the learning outcome data from control group is the interaction data experimental group.

Control group and experimental group were designed as requirements of the research model. Informing the groups, distinct consideration were given to the group of students with similar characteristics. Only one lecturer conducted the lecture to the whole study group to minimize the lecturer's impact on the study, and the researchers participated just as observers. Academic performance scale was used in "C# Programming" lecture in order to determine the performance of ITS Students.

The performance tests were applied to 56 students of daytime and evening classes of the Department of Information Technology as a pre-test. At the finale of this study, the post test using the same instrument was administered to the groups. The achieved data were analyzed using SPSS. In the analysis section related to the data of academic performance test, control and experimental t-tests were used where two variables exist.

The characteristics of the study groups are as follows:

- Experimental Group. This group was provided with education in Intelligent Tutoring System in programming using "C# programming" in addition to the traditional learning environment.
- Control Group. In this group, education was imparted through the conventional teaching strategies and learning environment with the material prepared as a rule of thumb.
- The validity and reliability of the instrument was calculated utilizing the scale designed by the researchers. The development phases of this scale and the calculations related to its validity and reliability are described. The process of data collection started from the development of the performance test comprising of 47 items related to units of programming "C# Programming Language" which was administered to the study groups coming from the third-year Information Technology students.
- The performance test was administered to a total of 162 students broken down as follows; second year (59 students), third year (69 students), and fourth year (34 students) who had taken the lecture before in order to ensure validity and reliability. Expert opinions were taken for the performance test initially consisting of 70 questions to determine the test's content validity. Necessary changes were made based on the experts' opinions. All the items in the test were

multiple-choice questions each of which is 1 point, after the supervision of the test, the necessary analysis was made.

- The difficulty and relevance indexes of each item were calculated and items with relevance index of less than .20 were removed from the test leaving 47 items which formed the achievement test. Data related to item analysis is presented in Table 1. It can be concluded that the test item difficulties range from .33 to .90 which includes easy and difficult items. The average difficulty of the test was found as .69. When considering the ideal average test difficulty being .50, the test was accepted as a medium difficulty which is "desired average difficulty." The reliability coefficient of the test was calculated as .75 based on the KR20 formulation.

IV. RESULTS AND DISUSSION

In this study, the pre and post-test were administered toward the students using the performance test. Statistical calculations were made on the scores of students in line with the hypothesis. The findings and comments related to hypothesis connected to performance test are given below:

TABLE I. DIFFICULTY (P) AND RELEVANCE (R) INDICES OF THE ITEMS

Item number			Difficulty index (P)			Relevance index (R)		
1	17	33	.87	.78	.65	.31	.32	.29
2	18	34	.83	.85	.86	.33	.32	.28
3	19	35	.86	.79	.65	.22	.46	.22
4	20	36	.85	.86	.65	.25	.41	.35
5	21	37	.60	.86	.60	.33	.47	.35
6	22	38	.83	.67	.72	.28	.44	.23
7	23	39	.69	.78	.54	.28	.44	.23
8	24	40	.83	.67	.72	.21	.30	.37
9	25	41	.84	.63	.57	.34	.35	.37
10	26	42	.65	.57	.77	.27	.32	.29
11	27	43	.81	.83	.64	.24	.36	.21
12	28	44	.81	.83	.64	.33	.23	.24
13	29	45	.33	.72	.69	.33	.25	.26
14	30	46	.90	.62	.75	.31	.40	.25
15	31	47	.72	.73	.90	.33	.34	.30
16	32		.35	.67		.24	.24	

The result of the reliability test was taken into consideration and concluded that the performance test is reliable. The obtained data and statistical calculations can be seen in Table II.

TABLE II. PERFORMANCE TEST ANALYSIS RESULT

Number *(N)*	Arithmetic mean *(X)*	Standard deviation (*Sd)*	Average difficulty (P)	Reliability KR20
162	48.44	6.80	0.69	0.75

Table III clearly indicates significant difference at the level of (p< 0.024) between the control and experimental group. The arithmetic mean of the control group was (X=29.28) and experimental group was (X=36.25). The result revealed that the Intelligent Tutoring System had significant effect on the academic performance of students. The result of the t-test=14.15 on the academic performance conducted during pre-test and post-test indicated that there is a significant effect on the academic performance of the students which supports the hypothesis 1 that there is a significant difference between the control and experimental groups scores in terms of academic performance.

TABLE III. PRE-TEST VERSUS POST-TEST RESULT RELATED TO ACADEMIC PERFORMANCE

Group	N	X	SS	*t*	Significance level
Control	28	28.28	5.68		
					0.024
Experimental	28	36.25	4.54	14.15	

As gleaned from Table IV, an arithmetic mean of (X=28.92) for the pre-test and (X=33.14) for the post-test revealed that there is a significant difference between the two at the (p < 0.016) level. The result of the t-test=6.66 revealed which supports the hypothesis 2 which states that there is a significant difference between the control and experimental group scores in terms of perceived use of portal.

TABLE IV. PRE-TEST VERSUS POST-TEST RESULT RELATED TO PERCEIVED USE OF A PORTAL

Group	N	X	SS	*t*	Significance level
Control	28	28.92	5.52		
					0.016
Experimental	28	33.14	6.22	6.66	

Table V avers the result of the t-test=0.234 conducted which supports hypothesis 3 stating that there is a significant difference between the pre-test and post-test scores in terms of analytical skills with (X=29.28) for the experimental group and (X=28.92) for the control group at (p<0.05) level of significance and a significant difference of (p = 0.815).

TABLE V. PRE-TEST VERSUS POST-TEST RESULT RELATED TO ANALYTICAL SKILLS

Group	N	X	SS	*t*	Significance level
Control	28	28.92	5.86		
					0.815
Experimental	28	29.28	5.52	0.234	

Hypothesis 4 stating that there is a significant difference between the control and experimental scores in terms of problem-solving is supported by the t-test=2.13 outcome shown in Table 6 that control group has (X=33.14) while the experimental has (X=36.25) showing a significant difference of (p = 0.038), which states that there is a significant difference between the control and experimental group scores in terms of the problem-solving.

TABLE VI. PRE-TEST VERSUS POST-TEST RESULT RELATED TO PROBLEM-SOLVING

Group	N	X	SS	*t*	Significance level
Control	28	33.14	6.22		
					0.038
Experimental	28	36.25	4.54	2.13	

Table VII shows the summary of differences between the pre and post-test scores of the control and experimental groups related to academic performance, perceived use of the portal, analytical skills and problem-solving.

TABLE VII. SUMMARY OF PRE-TEST AND POST-TEST ACADEMIC PERFORMANCE, PERCEIVED USE OF PORTAL, SKILLS AND ANALYTICAL, AND PROBLEM-SOLVING SCORES

	Pre-test *X*	Post-test *X*	*t-test*	*P*
Control	28.92	33.14	0.36	0.038
Experimental	29.28	36.25	3.11	0.815

(p <0.05)

An arithmetic mean of (X=28.92) and (X=29.28) for the pre-test of the control and experimental group respectively and post-test of (X=33.14) for the control group and (X=36.25) for experimental group derived a difference of (t-test=0.36) at the level of p < 0.05 (p = 0.038) under the control group and a difference of (t-test=3.11) at the p <0.05 (p = 0.815) for the experimental group. The summary of results supports all the hypothesis that the use of Intelligent Tutoring System has a significant difference and had a positive effect on all the variables namely, academic performance, perceived use of the portal, analytical skills and problem-solving.

When considering the performance of the students in general, the fact that the academic performance, perceived used of portal, skills, and problem solving of the experimental group is significantly greater than the control group is an important finding of the study proving that the Intelligent Tutoring System has an impact on the academic performance of students in programming using C#.

V. CONCLUSION

Based on the findings, the following conclusions are drawn:

- The arithmetic mean of pre and post-test belonging to the academic performance score, perceived use of the portal, analytical skill and problem-solving were analyzed statistically with a significant difference were found in favor of experimental group. The results of the hypothesis show that in Intelligent Tutoring System had a significant difference and had a positive effect on the students.

- The arithmetic mean of post-test belonging to the experimental group which received instruction in the Intelligent Tutoring System in terms of academic performance, perceived use of the portal, analytical skills and problem-solving was analyzed statistically with t-test of (p = 0.815) points which is a significant difference of the level of $p < 0.05$ ($p = 0.038$).

- The designed ITS in the form of Python, PHP stands for Hypertext Pre-processor and Java Script page online provides assistance to students with course materials containing achievement test to be able to recommend learning goals and coming up with appropriate topics suited to the student's knowledge level, one after the other into the sequential webpages. In ITS course materials, it will be able to act flexibly and able to respond to the student's individual needs based on their assessment. - The intelligent features is the highlight of the system as there are personal information collected from students that tells they know how they derive education and receive pedagogical decisions from the system.

- The study was conducted as a prelude to a comprehensive study on this is shown in Figure 4. The impact of ITS in Programming: A Case Study in Improving Academic Performance of Student in Tertiary Education. It is recommended further study should be conducted focusing on the following variables namely: academic performance, perceived use of the portal, analytical skills and problem-solving.

ACKNOWLEDGMENTS

The authors wish to thank the students of the tertiary education for the success of the survey study as well as the constructive comments of the reviewers in the IPSITENCRRC2019.

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