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Programming Competencies of Filipino Information Technology Students: Inputs to Improving Instructional Processes

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Abstract
With the changing trends of employability and industry requirements, this study aimed to look into parameters affecting the level of competency of the 60 senior Filipino Information Technology of a state university in Northern Philippines. Data along profile variables, programming language preference, level of competency in terms of the programming abilities were obtained througha structured questionnaire, rubric-based skills assessment streamlined from TESDA standard, and complemented through interviews and document reviews. Findings revealed that the very good competency level of the students was attributed from prior knowledge imparted by their teachers in terms of lectures and hands-on activities, self-learning by exploring the internet for some enrichment, and others sought help from peers/classmates. Furthermore, it was found that students have poor study habits as well as the low efficiency of the students in developing a system. Results of the t-test showed a significant relationship exists between the respondents' competency level according to their age and sex. Younger and male students tend to have a higher competency level along with general programming. Findings suggest that the programming teachers needs to be gender-fair in upscaling skills and competencies of Information Technology students along with general programming, databases, and web development.

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I. INTRODUCTION

A. Background

Information Technology has a tremendous contribution to the great fast-changing lives of today. The great innovations it brought about that everybody across the globe embraces into it. We are now on a fast-paced change society and fast way life in which non-stop enhancement of computer hardware as well as software. The modern trend of today is Automation brought about by Information Technology. And automation could be developed through programming. These were all made possible through programming. Outputs/products of information technology could be neither created nor utilized without the software or program installed in it. Programming languages are the platforms that were used to create programs that make programmer's work done easier and faster effectively. Created programs or developed software are also tools in solving scenarios that require problem-solving and eventually increases productivity. Nevertheless, the use of abstraction from the "general idea" that seemingly avoiding the details of actual problem solving and the end-user speed and complexity for faster development are the battle cry of modern software development. This should be the mindset of information technology students.

Philippines is now projected to be the next ICT hub and best breeding ground for ICT professionals in Asia. For this stance, our country was tasked to develop an ICT-equipped workforce with the right competency to serve the future demand and its advancement and progress in the field of ICT. Mr. Joaquin Quintos, President of IBM said that ICT industry had recently been growing at a sustainable rate that an increase in ICT employment prospects is foreseeable and expected in few years' time but likewise reminded that there is a rampant mismatch

between school curricula and industry demand. Right skills pertain to continually upgrading of one's knowledge, competence and skills in IT[1].It was also found by Joey Gurango through Gurango Software Corp. (GSC) which administered the first Proxor examinations in the Philippines from October 2015 to September 2016 that over 50% of Filipino students lack basic entry-level programming skills that meet globally acceptable standards [2].

Cagayan State University at Aparri offers Bachelor of Science in Information Technology, providing the most in-demand Programming Languages like Java, C++, Visual Basic; for database we have SQL Server, MySQL; and for Web, HTML, PHP. Also, these are the most widely used programming languages, both in industry and education. This is the reason why its enrolment data is greatly increasing. Many students take the course because it is in demand in our country and abroad. An Information Technology graduate can be data encoder, system analyst, instructor, network administrator, webpage developer, and programmer. But the problem is that, as IT students proceed in their level of tertiary education, their number is greatly decreasing. And the major reason why this happens is that they find difficulties in programming. Programming is proven as one of the most breath-taking subjects of those who are taking computer-related courses. Syntax and forms of any programming language are very hard to understand. Another is analyzing problems is a very difficult task. Some other factors identified why they are hard up in programming are an insufficient number of computer units, insufficiency of books and other resources. According to Javier, skill and knowledge deemed important in the exercise of their functions. IT program objectives, components, and processes were attained, implying that the University had attainable objectives including a responsive IT curriculum and instructional systems, competent and technically knowledgeable teachers, and adequate physical facilities. Instructional systems, convenient classroom and school buildings were contributory to graduates' employability [3].

This is the premise of this study. Vision for competency that includes improving instructional pedagogies, guidance on which one to choose, industry demands, the present trends, and market appeal. Specifically, Programming competency assessment is a vital determinant for the standing of the students; discovering their preferences, strengths, and weaknesses; assessing students for proper matching of job assignment; and to gauge the fourth year students' readiness in their OJT deployment and eventually for their future career.

B. Objectives of the Study

The study aimed to assess the level of Programming Competency of the Fourth Year Information Technology students of Cagayan State University at Aparri.

Specifically, it determines the profile, GPA in programming subjects, programming language preferences, the self-perceived level of knowledge on General Programming, database, and web programming. It also assesses the level of Actual Performance (skill) in Programming as perceived by the students. Further, it identifies whether sources of knowledge of the students on programming were attributed from teacher/class lectures, hands-on activity, own researches/ individual effort and peer tutoring.

It is also deemed necessary to look at whether there is a significant relationship between the profile of students and their level of programming competence. Also, is there a relationship between the perceived knowledge and actual performance of the students?

II. METHODS

The study, conducted in Cagayan State University, Cagayan Valley, Northern Philippines, used the descriptive-correlational and survey method obtaining the responses of senior Information Technology students. The questionnaires were streamlined from NC-IV of TESDA. The same was evaluated and validated by experts. Conducted in the second semester of SY 2016-2017.The floating of the self-assessment questionnaire (knowledge test) was done manually and was collected and validated through interviews. Multiple responses were allowed on the attributes. The skills test for all senior IT respondents was also done in this study. The skills test was conducted at the computer laboratory. The respondent's outputs were scrutinized and

evaluated by experts following a corresponding rubric for each. Responses taken were gathered, validated, and collated. The profile of the 60 respondents, their perceived knowledge and the result of the skills test, were described.

III. RESULTS

A. Profile of the Respondents

- **Age**

Table 1 presents the frequency of respondents according to their age to see the distribution for further comparison. This is one of the profiles that were considered to test the hypothesis.

Table 1. Distribution of students according to age

Age	Frequency (n=60)	Percentage
19 – 20	41	68.33
21 – 22	11	18.33
23 – 24	3	5
25 – 26	1	1.67
27 – above	4	6.67
Mean	**20.85**	
SD	**2.33**	

- **Sex**

Table 2 shows the frequency and percentage distribution of the respondents in terms of sex for further comparison. This was another profile factor that was correlated in the study.

Table 2. Distribution of students according to sex

Sex	Frequency (n=60)	Percentage
Male	21	35
Female	39	65

- **General Point Average (GPA)**

The General Point Average was the consolidated grades of the students in all Programming subjects included in their curriculum. It was further got by computing the mean.

Table 3.Distribution of students according to general point average

GPA	Frequency (n=60)	Percentage
78 – 80	1	1.67
81 – 83	7	11.67
84 – 86	19	31.67
87 – 89	17	28.32
90 and above	16	26.67
Mean	**86.83**	
SD	**3.088**	

- **Programming Language Preference (PLP)**

The table shows the listing of the programming languages learned by the students which are integrated into the curriculum.

Table 4.Distribution of students according to programming language preference

Programming Languages	Frequency (n=60)	Rank
C++	2	6
Basic	25	2
PhP	10	3
Java	6	4
Html	36	1
.Net	3	5

B. Knowledge Level as Perceived by the Students

Table 5 composed of the self-assessment statements as a basis for the respondents to rate themselves as to the level of their understanding (knowledge) in general programming, database programming and Web programming with the computed weighted mean for each statement, and the corresponding descriptive value. The statements were reliably streamlined with the TESDA Assessment Tool in NC IV Programming. The following are the programming areas where they were assessed:

- **General Programming**

There are two main criteria that are designing program logic and writing program code. Designing program code entails determining design approach in coding, structures diagrams of program flows, modules and links required to project standards. It also identifies and revises references for tables, files, inputs, outputs and other program functionalities, states, and conditions for interfaces and compliance to design documentation and uses naming conventions. Writing program code considers basic language syntax rules and best practices. The uses of language data-types, operators and expressions, arrays and arrays of objects, program debugging techniques were also evaluated. It also confirms the coding process meets design specification to develop and constructs simple tests and make corrections if needed.

- **Database Programming**

It assesses how to manage databases from setting up, entering and updating data, format fields and layouts. Sorting, filtering data, and normalizing tables in databases, running a query to produce a report are important parameters to consider.

- **Web Programming**

It assesses their knowledge on what is web designing, following certain rules and guidelines in producing quality web pages. The questionnaire was broken down into specific statements for the respondents to answer. It includes the use of different editors in writing HTML documents, construct HTML tags using proper syntaxes and able to save and name HTML. Viewing the HTML documentaries as a web page in a browser.The compatibility of CSS to the browser. Create pages with motions and dynamic rendering of the content and use Plug-ins to display more sophisticated multimedia on the Web.

Table 5. Assessment of the knowledge level as perceived by the students towards general programming, database programming, and web programming

Categories/Criteria	Weighted Mean	Descriptive Value
General Programming		
Designing Program Logic	3.26	Very Good
Writing Program Code	3.27	Very Good
Database Programming	3.26	Very Good
Web Programming	3.34	Very Good
Overall Weighted Mean	**3.28**	**Very Good**

C. Skill Competency by the Students

- **Database Programming and Web Programming**

Table 6 presents the parameters used in the criteria devised in assessing the skill of the respondents. The criteria were reliably scrutinized by the panel of specialists, who at the same time the assessors. The specific criteria include logic, interface, database, functionality, conformity, and organization.

Table 6. Level of skill/actual performance in database programming and Web programming as perceived by the students

Criteria	Weighted Mean		Descriptive Scale
	Database	Web	

	Prog'g	Prog'g	
Logic	3.02	3.05	Very Good
Interface	3.2	3.4	Very Good
Database	3.41	3.7	Outstanding
Functionality	3.1	3.1	Very Good
Conformity	3.5	3.6	Outstanding
Organization	3.1	3.02	Very Good
Overall Weighted Mean	**3.23**	**3.31**	**Very Good**

D. Attribution Theory

This was gathered through interviews and tabulated for further comparison. This gives some insights on what are the students' sources of knowledge and skill that contributes to their mastery of Programming. The data gathered were multiple responses.

Table 7. Attributions of students' knowledge and skill

Attributes	Frequency (n=60)	Rank
Teacher	60	1
Self-learning	22	4
Researches/Internet	42	3
Peer	49	2

Table 8. Relationship between level of programming competence and their profile variables

Respondent's Profile	General Programming		Database Programming		Web Programming	
	Computed r	Inference	Computed r	Inference	Computed r	Inference
Age	-0.2606	S	0.223	NS	0.0652	NS
Sex	0.2564	S	0.1491	NS	0.1152	NS
General Point Average	0.1261	NS	0.13	NS	0.0349	NS
PLP	0.1	NS	0.066	NS	0.049	NS

Critical value of *r* at 0.05 level of significance with df=59 is 0.2523.

Table 9. Relationship between knowledge and actual performance as perceived by the students

	r value	r critical	Inference
Knowledge Actual Performance	0.831	0.211	Significant

df = 59

IV. DISCUSSIONS

A. Profile of the Respondents

- **Age**

It shows that the majority comes from a range of age brackets 19-20 with a percentage of

68.33. This is followed by 21-22 having 18.33 percent, the age bracket 27 and above having 6.67 percent, age bracket 23-24 having 5 percent, and the least is age bracket 25-26 with a percentage of 1 percent. This implies that most of the respondents are at the tertiary education level. The mean age is 20.85 years, and the sample standard deviation is 2.33. Furthermore, age significantly affects the competency level of the students.

- **Sex**

It was found that the majority of the respondents are female as reckoned by the frequency of 39(65 percent). This is the usual tendency in an educational community which basically is dominated by females. These data were used to compare the sex whether or not signifies a relationship to the competency level of the respondents.

- **GPA**

The GPA mean is 86.83, which shows the overall standing of the respondents with a standard deviation of 3.088. As stipulated in the student manual using the adjectival and arbitrary scales for their Grade Point Average, the overall standing of the respondents is *Very Good*. It further shows that 86.66 percent have grades of 84 and above, and just 13.34 percent who have grades of 83 and below. Grades perceived by students in all their programming subjects show that the respondents have generally high competency.

- **Programming Language Preference**

The distribution frequency shows that respondents are more interested in*HTML*, with the highest frequency of 36, followed by *Basic* with a frequency of 25, *PHP* with 10, *Java* with 6, *Net* with 3, and the least *C++* with only 2. Categorizing according to type, the enumerated Programming Languages: the top 3 languages according to rank are all object-oriented while the least 3 languages are procedural. It signifies that the majority of the respondents are more visual or object-oriented. They prefer most click and drag to execute commands than to plainly code a program. But it doesn't mean the students totally neglected the least preferred programming languages but the distribution only shows their preference in terms of priority.

Based on the result, *HTML, Basic and PHP* were the most frequently used by the students. This group of students appreciate more programming languages that have some templates to start with, they can employ color and layout designs, they can insert and modify images and a little of codes or syntax for the interface. They least prefer *Java, Net, and C++* because these are programming languages that need bulk of plain codes. The entire program was run by codes. A programmer of this kind needs a lot of abstraction ability. Therefore the respondents were poor on abstraction.

B. Knowledge Level as Perceived by the Students

- **General Programming**

The result shows the overall weighted mean of 3.27 with a descriptive value of *Very Good*. It implies a 95 percent overall self-rated standing of the knowledge level of the respondents in General Programming, with just 5 percent of being outstanding. In comparison with the respondents' Grade Point Average, it conforms to the overall standing of the respondents as they personally assess themselves, *Very Good*, in General Programming.

- **Database Programming**

The result shows the overall weighted mean of 3.26 with a descriptive value of *Very Good*. It implies a unanimous overall self-rated standing of the knowledge level of the respondents in Database Programming. In comparison with the respondents' Grade Point Average, it conforms to the overall standing of the respondents as they personally assess themselves, *Very Good*, in Database Programming.

- **Web Programming**

The result shows the overall weighted mean of 3.34 with a descriptive value of *Very Good*. It further shows 10 out of 42 *outstanding* rates and 32 out of 42 *Very Good* descriptive values. It gives da 23.81 percent "*Outstanding"* overall self-rated knowledge level of the respondents in Web Programming, and a76.19 percent of being "*Very Good".* In comparison with the respondents' Grade Point Average, it conforms to the overall

standing of the respondents, *Very Good*, in Web Programming.

C. Skill Competency by the Students

- **Database Programming**

The result shows that the computed overall weighted mean is 3.23 with a descriptive scale of "Very Good". As of level of competency, the parameter that had the highest weighted mean of 3.5 with the equivalent descriptive scale of outstanding is on conformity. Another area that the respondents achieved outstanding is at the database which has a mean of 3.41.

Generally, the level of competency for the rest of the parameters had a "Very Good" rating which means that the competency level of the fourth year Bachelor of Science in Information Technology students lies in the middle of the spectrum. The table shows that the level of competency of the respondents was rated "very good".

It was found that the respondents got outstanding on a database which means that they are good in data entry; and conformity which signifies that the students are using the appropriate specifications stated in the problem.

- **Web Programming**

A rate of "Very Good" was yield by the skills test conducted to the respondents and the result shows that the computed overall weighted mean is 3.31. As to the level of competency, the parameter that had the highest weighted mean of 3.7 with the equivalent descriptive scale of outstanding is on the database. Another area that the respondents achieved outstanding is at conformity which has a mean of 3.6. The result further implies that the students were hard upon logic and organization.

The same result as in Database programming was concluded. Generally, the respondents were data entry experts and they were able to perform all the specifications indicated/stipulated on the problem set. In comparison with the students' overall weighted mean on the two categories of programming, web programming is higher than the database programming. It further coincides with the previous findings that the students are more confident in object-oriented programming languages which were used in web programming.

D. Attribution Theory

Attributes on the competency level of the respondents were taken into consideration. The raw data of the above-listed attributes were gathered through interviews. The frequency counts teacher being the highest with 60, followed by the peer with 49, internet with 42 and self-learning with 22.

The table implies that the basic knowledge of the students in programming was acquired from the teachers, which had a perfect frequency count. The students' benchmark was on the prior knowledge imparted by their teachers, their first training ground of knowledge and skill is still on the teachers' lectures and hands-on activities, some explored the internet for some enrichment, others sought help from peers/classmates but it was found that students have poor study habit. The imparted knowledge by the teachers was not followed up by the students. During the interview, it was elicited from their responses that some only review their lessons during examinations.

E. Relationship between level of programming competence and their profile variables

A significant relationship exists between the respondents' competency level according to their age and sex reckoned by the computed value of r which is -0.2606 and 0.2564 respectively.

The result implies that younger students have a higher level of programming competence than older students in terms of General Programming. This finding was supported by the study of Andrew Colman (1997) wherein he stated that older adults hold more negative attitudes toward computer technology than younger people. He also stated that the older people perceived less comfort, efficacy, and control over computers than did the younger students. It further found that incoming students were more experienced with using a computer than the earlier students.

It was also found out that the level of programming competence of the males is higher than the females. This is supported the findings of Rod Corston (1996), wherein he stated that

anecdotal evidence suggests that computers appear to be perceived primarily as a masculine technology, and this tends to be confirmed by the sex distributions in school and college computer classes and amusement arcades.

Andrew Colman (1997) generally supports that females have less overall experience with computers and are more likely than males to have negative attitudes towards computers. Although limited, research on Internet experiences and attitudes has found parallel gender differences, with females reporting lower levels of experience and more negative attitudes. Males were more experienced with computers, more likely to have taken high school courses requiring computer use, and reported higher skill levels in applications such as programming, games, and graphics than females[5].

It was further proved by Huang, et. al. as cited by BrckaLorenz, that gender, and age, among other factors, can impact the level of technical proficiency students come to college [4].

F. Relationship between knowledge and actual performance as perceived by the students

Apparent in table 9 is the relationship between knowledge and actual performance of the students where the relationship test yielded significant as reckoned by the computed coefficient of 0.831. This implies that the knowledge of the students was directly related to their actual performance.

Many computer programming educators argue that abstraction is a core competence. And abstraction starts with the end of the mind. Nguyen & Wong (2001) claim that it is difficult for many students to learn abstract thinking; at the same time, they claim abstract thinking to be a crucial component for learning computer programming. The authors describe an objects-first-with-design-patterns approach with a strong focus on abstract thinking and development of the students' abstractive skills. The authors argue that abstraction is a fundamental concept in programming in general and in object-oriented programming in particular[6].

V. CONCLUSIONS

The competency level of the Filipino Information Technology students in Northern Philippines was generally very good and is attributed to the quality of instruction among teachers, self-learning, researches/internet, and peer. Younger and male students tend to have higher competency levels along with general programming than in databases and web development. Hence, it is recommended to improve instructional processes considering gender sensitivity among teachers, advancing the skills and competencies of the students especially along with databases, web development, and general programming.

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