Gender Differences in Learning Programming: An Analysis by Students' Perception

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Abstract: In computer science, an expected outcome of a student's education is programming skill. Although the teacher expects the students to master the programming language, there is a doubt whether the student had achieved the teachers' expectation. So it is desirable to get the students' view point on what they had achieved and what are the obstacles they come across. Thus, this study aims at investigating the students' perception towards programming and also whether the perception varies based on gender. 241 students who studied the subject Structured Programming at Sri Lanka Institute of Advanced Technological Education had attended the survey. Results show that although both male and female students believe programming is important for future career there is a strong gender affect in their perception on curricula and their ability of programming. The male students outperform female students in understanding the concepts, working in the programming development environment and fixing bugs. Male students find programming interesting and they tend to assist female students. Although programming is a practical based subject, both male and female students feel participating in lectures help them to learn programming better. For attitudinal change of female students and to enhance the performance of all students, teachers can use tools like Alice, Scratch to better visualize programs or techniques like pair programming, peer instruction to enhance student collaboration. The results of this study can be used as a base for future research on teaching methodology for programming subjects. Examining relationship between perception and performance will extend and expand the findings.

*Keywords***: Programming, Perception, Factors, Learning**

I. INTRODUCTION

In computer science, an expected outcome of a student's education is programming skill. (Alexandra Funke, 2001). In most computer science courses programming is taught from the beginning of the course and taught throughout many semesters advancing depth wise by digging into many theories and expanding breadth wise by introducing many programming languages. Although novice programmers lack the knowledge of experts it is a skill they should master in order to get a rewarding career.

Although the teacher expects the students to master the programming language which is taught, there is a doubt whether the student had achieved the teachers' expectation. Students especially novices, have problems in reading, tracking, writing and designing a simple code fragment. This causes students to have the attitude of depending on others to complete the task given and consequently become indolent and do not have the courage to learn and just expect marks of sympathy from lecturer (Derus & Ali, 2012) .The programming skills of students may develop with previous exposure to programming environment, with the level of analytical skills, with the attention during lectures, with the effort taken for practicing.

In most educational institutes, the programming knowledge of the students is evaluated at the semester end examinations. Up to some extent it is a measure of the students' knowledge, but it may depend on students' mentality during the examination, his writing ability and also the toughness of the question paper. It will not give any indication of the reasons behind weakness of some students in programming. So, it is desirable to get the students' view point on what he has achieved and what are the obstacles he comes across in the path of expertise in programming. By knowing that the management of the institute and education experts can bring strategies to facilitate the learning process. Thus, this study aims at investigating the students' perception towards programming and also whether the perception varies based on gender.

A. Background of the Study

Other than the state universities, as the only higher education institute under Ministry of Higher Education, SLIATE (Sri Lanka Institute of Advanced Technological Education) has taken the responsibility of creating excellent higher national diplomates with modern technology for sustainable development of the country. HNDIT (Higher National Diploma in Information Technology) programme of SLIATE had been established with the aim of providing information technology personal to cater to the demands in the current information technology field.

Programming is considered as one of the essential technical competency for a Sri Lankan software engineer (Manawadu, Gapar, & Perera, 2015). So programming is considered as a major component in HNDIT programme and it is taught in every semester during the two year academic period. In the first year main focus is teaching fundamental concepts of programming through languages such as C++ and Java. Two programming subjects are offered as core modules in the first year. In the second year students get the opportunity of learning .NET for standalone application development, PHP for web based application development and Android for mobile application development. At the end of the diploma

programme students have to submit a software system to demonstrate their programming capabilities. Other than the components in the curriculum the administration arrange software competitions and workshops to further enhance the programming skills of the students. Mastering a programming language leads to successful completion of diploma and also lays a strong foundation for a successful career. So programming related subjects are critical for every student who is following HNDIT programme.

B. Problem Statement

The performance of the students is considerably poor for the programming subjects which is clearly reflected in their end semester results and final year project. The students' programming knowledge were assessed by the end of semester examinations but there had been no effort to get the students' opinion on the difficult areas in programming subjects or identifying the practical issues students face while programming. This study focuses on getting students' perception about programming.

In light of previously discussed findings, several factors influence the poor performance in learning programming. For example computers that do not work, syllabus focuses too much on theory (Noor Azizah Mat Isa, 2017), less effective in teaching methodology (Rajendran, 2011), lecturers not providing enough examples (Derus & Ali, 2012) are among them. This study helps to verify whether the same reasons matter Sri Lankan students.

Although computer science is stereotyped as male dominated. (as cited in (Alexandra Funke, 2001)) there is an increase of female students in the HNDIT programme. This study aims at identifying whether there is a gender difference in students' perception towards programming as programming is a core subject that effects employability. The study is also concerned in examining whether difficulties in programming are gender specific.

C. Objectives of the study

The main aim of the study is to explore the views of male and female students towards programming by referring to the students registered for the HNDIT programme at SLIATE. In order to assist the aim, the study intends to achieve the following specific objectives:

- Determine the gender differences in the level of understanding of different topics of the programming subjects
- Investigate gender wise, the nature of difficulties while learning programming subjects
- Identify the factors that lead to perform poorly in programming subjects based on gender

Any programming subject covers topics such as variables, operators, control structures, arrays, methods and classes. This study will help to observe topics which are difficult for students in general as well as gender wise.

Program development life cycle consist of many phases such as define the problem, design the solution, code the program and test the program. Students may perform different activities in each phase and the difficulties they come across may differ according to the ability of designing, familiarity of the development environment, ability of debugging, etc. Thus this study aims at identifying the nature of difficulties students face while programming.

For students to perform better in programming it is a must to identify factors which leads to poor performance in programming and mitigate them. The factors may be individual such as lack of interest to learn, poor analytical skills, language barrier, etc or they may be environmental like lack of computers for practicing, syllabus focus too much on theory, learning environment is not conductive, etc.

II. LITERATURE REVIEW

Programming is a major subject in any computer science course. So acquiring programming skills as well as obtaining good grades is very important for programming subjects. So, the students' performance of the subject is measured in many ways such as projects, continuous assessments and end semester examinations. To expertise in the subject the student perception matters.

In the study done by Isa and Darus majority are students who do not have any experience in programming while 6% have some experience in programming. It is same for the study done by Isa and Ali where 97% of students have no experience in programming. The population of Milne and Rowe had previous experience in programming where 90% of them had used Java and 90% of them had used C++ before(Milne & Rowe, 2002).

Several research have been done to identify the most difficult area in programming. According to Rajendran et al Concurrent programming, UI components with Swing and Generic programming of Java are most difficult areas for CSE and IT students of Anna University India. (Sivasakthi & Rajendran, 2011) According to the research done by Isa and Derus with the students in a Polytechnic at Malasia , Array Data Structure is the most difficult area of programming for them. They have further analyzed this gender wise and realized that male students have less understanding in Functions and for female students Looping Statement and Selection Statement are more difficult (Isa &Derus, 2017). Based on the results of the study of Derus and Ali , Multidimensional Array, Looping Statements, Function and Array Data Structure are the difficult topics for students (Derus & Ali, 2012) It is difficult to compare the results of all researches as the topics of programming they considered in their studies are different for each of them. It is noticeable that some researches have considered specific programming languages such as Java when preparing the questionnaire.

Rajendran et al identified designing a problem to solve a certain task is the most difficult task for the students while it is second to understanding the basic concepts of programming

structure in Derus and Ali's findings. (Sivasakthi & Rajendran, 2011) (Derus & Ali, 2012)The study results of Isa and Darus is same as of Derus and Ali where both genders faced the highest difficulty in understanding basic concepts of programming structure. (Isa & Derus, 2017)

Identifying reasons for poor performance of programming may help to mitigate them in future. Thus many researchers have paid attention for that fact as well. Some students highly stated that less effective in teaching methodology which led them to perform poorly while learning Java programming. Less real world examples in class room teaching and less examples in practical use were also the major factors for poor performance. (Sivasakthi & Rajendran, 2011) According to the study of Isa and Darus computers in the laboratory that are out of order is a key factor for students to be week in programming. As a result of non functional computers the students have to share the computers which leads to getting less time to do practical (Isa & Derus, 2017). Derus and Ali identified eight factors which leads to poor performance in programming and lecturers not providing enough examples is the most effective factor. Computers that do not work and also method of teaching by the lecturers is less effective had been an issue for them. According to the above findings external factors lead to poor performance in programming rather than personal factors such as lack of interest or language barrier.

It is desirable to get the students' opinion towards the most efficient way of learning programming. Some students state that through practical and lab sessions they can learn a programming language effectively. Further they state that discussion with others might be helpful compared to small group exercise sessions. (Sivasakthi & Rajendran, 2011) Derus and Ali got the same opinion from their study group where majority of students agreed that the practical or laboratory activities could help them to learn fundamental programming effectively as well as to holding discussions together with lecturers or friends. (Derus & Ali, 2012)

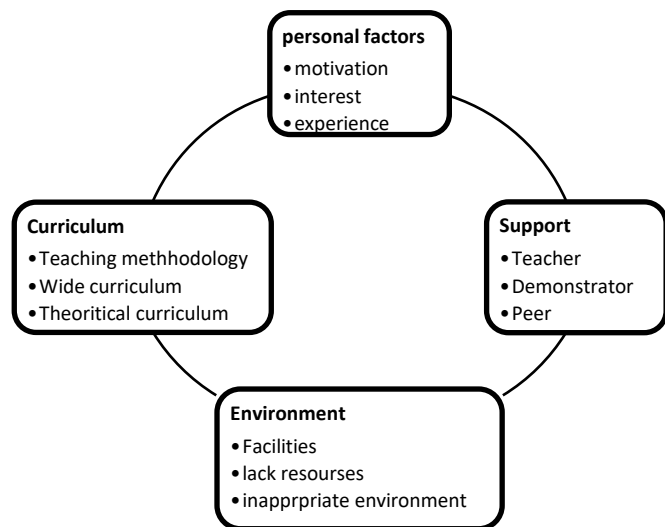*A. Conceptual framework of the study*

Fig 1: Conceptual Framework

Personal Factors: The students' interest in joining the course, their motivation of resolving programming issues and their previous experience in using a programming language is considered.

Support: The teacher's support during lectures, demonstrators' attention during practical sessions and support from peers in resolving programming errors is considered here.

Environment: Considered the facilities provided by the institute such as enough computers, the resources the students' have such as internet facilities, laptops, etc and the conductive environment

Curriculum: Here, how the curriculum is delivered i.e. the teaching methodology, whether the curriculum is set up too theoretically or it is practical based and the complexity of the topics covered are the facts considered

III. METHOD

A. Participants

The target population consist of first year students following HNDIT at SLIATE and by number there are 1735 individuals as at 2018 academic year. They are from all the 17 institutes spread island wide which are offering HNDIT . The minimum education level of the individuals is G.C.E. (A/L) any stream and their medium of study is English. The appropriate number of participants for the study was determined using Krejcie and Morgan Table. The required sample size is 317 with 95% confidence and ±5% margin of error. All the participants are HNDIT 1st year students in year 2018. Female participants (n = 169) outnumbered male participants (n = 94).

B. Sampling Design

Cluster sampling is used to select the sample units. Seven Advanced Technological Institutes had been selected randomly through the lottery method. All the students of those ATIs had been considered as sampling units.

C. Materials and Procedures

Data was collected by means of self-administered questionnaire. The rationale for choosing this method was increasing the response rate from highly distributed group of respondents and letting the respondents answer at their convenience.

The survey instrument was divided into three sections. Section One: Programming Experience and Motivation, Section two: Problems and problem solving approaches, Section three: demographic information.

A pilot test had been carried out with five students in the researcher's institute. After a focus group discussion with them the questionnaire was modified and finalized. At the end of the semester the researcher visited the selected institutes, explained the purpose of the study to the HNDIT first year students. The student participation was volunteer

and verbal consent has been taken before distributing the questionnaire. The printed questionnaire was distributed among the selected students and 10 minutes was given for answering.

IV. RESULTS

A. Motivation

Majority who joined for HNDIT prefers HNDIT course over other courses in the institute. Among them 83% male students and 84.6% female students had chosen HNDIT as their 1st choice. So there is an equally likely preference between genders for HNDIT course. 1% a 81% ,

Figure 2 provides clear evidence that most of the students have chosen HNDIT on their own wish. Most male students have chosen HNDIT on their own interest while most female students have chosen HNDIT for parents' interest.
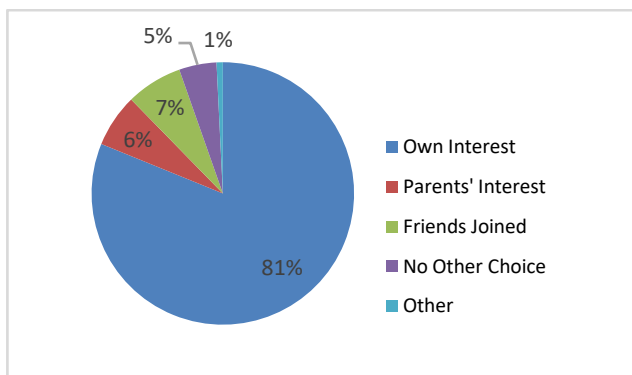

Fig 2: Reasons for Choosing HNDIT

More than half of the students are motivated towards programming to get a good career .Only 9% are interested in getting a good grade. When compared gender wise female students are more concerned about getting a good career when compared with male students.

Most tend to search internet when they get an issue in programming practical sessions. So most are self motivated as they are not using other options available such as ask from lecturer or demonstrators or else seek help from peers. Table 1 reveals that 46.8 % male students search internet to resolve programming issues opposed to 34.4% female students. Further, there is a significant observation that compared to male students more female students tend to seek help from any external party such as lecturer, demonstrator, male friends, female friends when they face an issue.

| TABLE I :WAYS OF RESOLVING PROGRAMMING ISSUES GENDER WISE					
Gender			Responses		Percent of Cases
			N	Percent	
Male	Resolve_ Issueᵃ	search internet	66	46.8%	71.0%
		ask lecturer or demo	31	22.0%	33.3%
		ask male friends	31	22.0%	33.3%
		ask female friends	13	9.2%	14.0%
		Total	141	100.0%	151.6%
Female	Resolve_ Issueᵃ	search internet	76	34.4%	45.5%
		ask lecturer or demo	55	24.9%	32.9%
		ask male friends	58	26.2%	34.7%
		ask female friends	32	14.5%	19.2%
		Total	221	100.0%	132.3%
a. Dichotomy group tabulated at value 1.					

B. Perception

Overall, students feel programming is difficult and particularly the female portion expressing that claim is significant. More precisely stating, 62.1% female students believe programming is difficult while 36.2% male students believe so. Only 40% students believe programming is interesting and the male proportion is as double as female proportion stating that claim.

About 90% of the students believe that programming is important for future but more than half of the students are not sure whether they can score a good grade for programming. About 60% of the students think that programming is not easy to understand yet they believe it is interesting.

Mann-Whitney test indicated that

- Both male students (N=94) and female students (N=164) students equally likely believe that programming course is important for future career. (U=7707, p=0.998)
- male students (N=94) believe more than female students (N=164)that programming is an interesting subject (U=6640, p=0.015)
- male students (N=94) believe more than female students (N=164) that they can score a good grade for programming (U=6923.5, p=0.05)
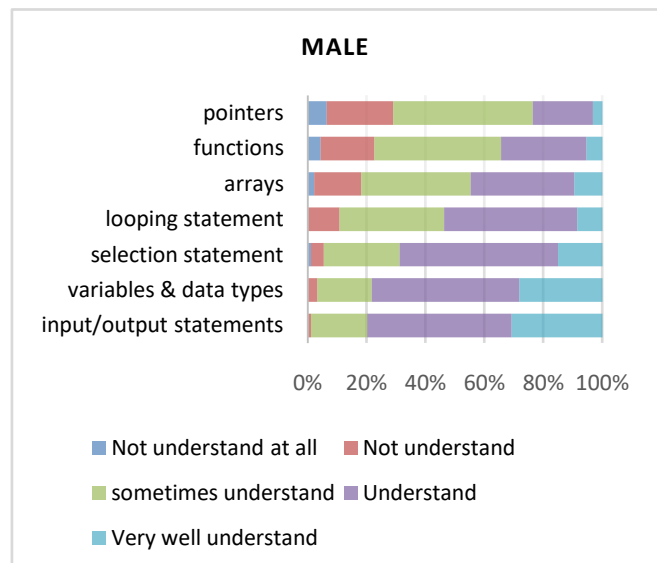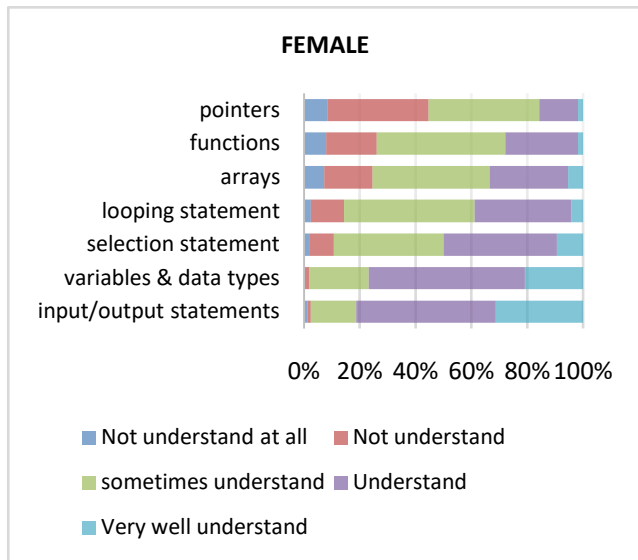
Fig 2: Levels of Understanding on Different Topics by Gender

C.   Problems &Problem Solving Approaches

    1)   Problems :

For both genders the basic concepts of programming ie. input/output statements, variables and data types are the topics which can easily be understood. Pointers seems to be the most difficult topic for both genders and for females it is much more difficult than males.

Mann-Whitney test indicated that

- Female students (N=164) find it more difficult than male students (N=94) in designing a program using a flow chart (U=6141,p<0.001)
- Female students (N=164) find it more difficult than male students (N=94) to find bugs in the program (U=5959.500,p<0.001)
- Female students (N=164)find it more difficult than male students (N=94) to understand program language syntax (U=6.312E3,p=0.002)
- Female students (N=164) find it more difficult to work with program development environment than male students (N=94). (U=6061.500,p=0.01)

Reasons for poor performance in programming was analyzed under the categories teaching issues, personal issues and environmental issues. Students were asked to rank each issue and the average rank was calculated as follows.

$$average\ rank = \frac{\sum_{i=1}^{n} x_i\ w_i}{total\ response\ count}$$

  Where

  w = weight of ranked position

  x = response count for answer choice

As per the results, irrespective of the gender most students feel helpfulness of instructors and their attention on students is less. Majority has mentioned too much theory on the syllabus is the least relevant issue for them. Lack of interest to learn programming is the most critical personal issue of the students. When analyzing gender wise for the females lack of interest to learn programming is the most critical personal issue they had for poor performance in programming. Most student opinion is learning environment that is not conductive leads to poor performance in programming. When analyzing gender wise female students have stated the same reason while male students say that computers provided in the lab are not functioning well thus it has been a reason for their poor performance in programming.

    2)   Problem solving approaches:

According to the figures of table 2 mostly "kuppi" classes are conducted by male seniors followed by male colleagues. "Kuppi" are informal teaching sessions conducted by students for their fellow students to help in academic work.

TABLE2: The Groups Who Conducted Kuppi Classes				
		Responses		Percent of Cases
		N	Percent	
support from[a]	male seniors	193	47.2%	77.5%
	female seniors	69	16.9%	27.7%
	male friends	109	26.7%	43.8%
	female friends	38	9.3%	15.3%
Total		409	100.0%	164.3%
a. Dichotomy group tabulated at value 1.				

Gender wise analysis reveals that the opinion of both male and female students on the factor which help them to learn programming is participating in lectures. While male students believe that following LMS course is least helpful for them to learn programming, female students believe working alone on programming is least helpful.

There is no difference between the preference of male and female students regarding the teaching method and both groups prefer lecturing method. For both genders project approach is the least preferred method.

V. DISCUSSION

Gender differences in factors associate with perception towards programming was identified in the conceptual framework.

- Personal
- Support
- Environment
- Curriculum

Gender wise analysis of the above factors is given below

Personal

Personal factor was measured by the parameters; students' interest in joining the course, their motivation of resolving programming issues and their previous experience in using a programming language.

The percent of male students having previous experience in programming is nearly the same as of female students but male students have chosen the course on their own interest while female students have chosen it because of the influence of their parents. The male proportion stating that programming is interesting is as double as female proportion and as male students feel it is interesting they tend to resolve programming related issues on their own, for example by searching internet. By the results it is clear that males outsmart female in sharing the knowledge and providing support for academic work. For female students lack of interest in learning programming is the most critical issue they face.

The results of hypothesis testing indicate that that both male and female students equally likely believe that programming course is important for future career but male students believe more than female students that they can score a good grade for programming

Support

The teacher's support during lectures, demonstrators' attention during practical sessions and support from peers in resolving programming errors is considered here.

Female students feel programming is difficult. As a percentage it is 62.1% of all students. Thus when they face programming related problems they tend to seek help from lecturers, demonstrators or from peers. When the students were asked to rank factors that help them to learn programming, least rank was given to 'working alone on programming'. That opinion is going along with how they resolve programming related issue; i.e seeking help from an external party.

Environment

Here considered the facilities provided by the institute such as enough computers, the resources the students' have such as internet facilities, laptops, etc and the conductive environment.

Most students' opinion is learning environment that is not conductive leads to poor performance in programming. When analyzing gender wise female students have stated the same reason while male students say that computers provided in the lab are not functioning well thus it has been a reason for their poor performance in programming.

Curriculum

Here, how the curriculum is delivered i.e. the teaching methodology, whether the curriculum is set up too

theoretically or it is practical based and the complexity of the topics covered are the facts considered.

Majority of the students understand the basic concepts of programming such as input/output statements, variables , data types and control structures. Pointers seem to be the most difficult topic for both genders and for females it is much more difficult than males. According to hypothesis testing results, female students find it more difficult than male students to understand program language syntax, find bugs in the program and also to work in the programming development environment .Although programming is a practical based subject, both male and female students feel participating in lectures help them to learn programming better. So among various teaching methods such as lecturing, lab sessions, continuous assessments, e – learning approach they prefer lecturing method most.

VI. CONCLUSION

This study tried to investigate the effect of gender on the perception towards programming. The male students have a more favorable attitude towards programming compared to girls. They face less issues when writing programs and they tend to resolve them on their own. The male students tend to provide support for peers and juniors. Both genders believe programming is important for them to get a good career yet female students feel lack of interest in learning programming is an issue for them. For most of the students, preferred teaching method is lecturing method which contrast with previous research findings. (Derus & Ali, 2012)As programming is a practical based subject, effectiveness of learning can be increased by practicing.

This study's findings offer a variety of further research ideas. For example future research may incorporate both teacher and learner perspective. The results of this study can be used as a base for future research on teaching methodology for programming subjects. Examining relationship between perception and performance will extend and expand the findings.

A. Recommendations

The female proportion of students in the population is higher than males. Females students' interest is less in programming and they tend to seek help more. So to increase the interest, the teachers can use tools such as Alice, Scratch to better visualize the programs or techniques like pair programming, peer instruction to enhance student collaboration.

Although programming is a practical based subject, both male and female students feel participating in lectures help them to learn programming better. Attitudinal change of students can be done by introducing more student centric activities such as lab sessions, small group exercises.

Both genders feel helpfulness of instructors and their attention on students is less. Thus, the administration can arrange workshops to change attitudes of the instructors.

B. Limitations

As with all research certain limitations present. The study was limited to first year HNDIT students in SLIATE but expanding the target group to second years may help to get more vivid and precise results.

It would be appropriate to compare the situation with other universities

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