Investigating Students' Achievements in Computing Science Using Human Metric

Ezekiel U. Okike
Department of Computer Science
University of Botswana
Gaborone, Botswana

***Abstract*—This study investigates the role of personality traits, motivation for career choice and study habits in students' academic achievements in the computing sciences. A quantitative research method was employed. Data was collected from 60 computing science students using the Myer Briggs Type indicator (MBTI) with additional questionnaires. A model of the form $y_{ij}=\beta_0+\beta_1 x_{1j+}\beta_2 x_{2j+}\beta_3 x_{3j+}\beta_4 x_{4j+}\ldots\beta_n x_{nj}$ was used, where y_{ij} represents a dependent variable, $\beta_0+\beta_1 x_{1j+}\beta_2 x_{2j+}\beta_3 x_{3j+}\beta_4 x_{4j+}\ldots\beta_n x_{nj}$ the independent variables. Data analysis was performed on the data using the Statistical Package for the social sciences (SPSS). Linear regression was done in order to fit the model and justify its significance or none significance at the 0.05 level of significance. Result of regression model was also used to determine the impact of the independent variable on students' performance. Results from this study suggest that the strongest motivator for a choice of career in the computing sciences is the desire to become a computing professional. Students' achievements especially in the computing sciences do not depend only on students temperamental ability or personality traits, motivations for choice of course of study and reading habit, but also on the use of Internet based sources more than going to the university library to read book materials available in all areas**

Keywords—academic achievement; personality traits; computing science; study habits

I. INTRODUCTION

Achievements in educational terms refer to academic achievement. It is the performance of a student in his studies at school. Student's achievement in school subjects such as Mathematics, Physics, and Computer Science is a measure of the overall academic ability and knowledge of a subject of study. Although there exists a number of achievement studies in the subject areas like Mathematics, Physics, Chemistry and Biology, this is not the case in Computer Science especially at the university level. The need to measure students achievement in computing science among other things include the following: to ensure that students meet their set academic goals, to ensure students meet graduation requirements, to serve as a means to validate teaching effectiveness, and to serve as a means to identify outstanding students for recognition.

Every university takes as priority the learning standards and outcomes of her students. Hence universities adopt different approaches to measuring students academic achievement. A common approach used by many universities to measure academic achievement of students is by means of Continuous Assessment (CA), and final examination. In this regard, the CA mark could be between 30%-40% while the final examination score could be 60%-70%. Furthermore, universities have tools that help in ascertaining how well a subject has been taught by a lecturer and how well the students understood and mastered the course content. An example of this tool at the University of Botswana is the Students Evaluation of Courses and Teaching (SECAT) tool. Using this tool, the course, the student and the course lecturer are evaluated by the students through an automated questionnaire which reports its analysis as soon as students complete the SECAT questionnaires. Although the use of this tool is a good way to measure how well a course has been taught by a lecturer, and how well the students have mastered the course content, there remains a gap to be investigated between the students inherent personality trait and students achievement in each course of study. This paper investigates students achievement in Computing Science using 60 third year students of Computer Science (CS), Information Technology (IT), Computing with Finance, and Information System (IS) at the University of Botswana, Gaborone. This study is motivated by the interest to contribute to the empirical body of knowledge about using a human metric tool such as the Myers Briggs Type Indicator (MBTI) as a predictor of students' achievement especially in the Computing Sciences.

The term Computing Science encompasses Computer Science (CS), Computer Engineering (CE), Software Engineering (SE), Information Technology (IT), and Information Systems (IS). For the purpose of this study, courses offered by students in the Department of Computer Science leading to the award of Bachelor of Computer Science (BSC 280), Bachelor of Information Technology (BSC 204), and Bachelor of Computing with Finance (BSC 205) and Bachelor of Information Systems (BIS 230) are considered. All courses offered in these programmers cover hardware and software courses representing the four subdivisions of Computing Science as defined by the educational curriculum committee of the professional body in charge of computing education worldwide [1].

A. Problem Statement

The use of a human metric tool such as the Myers Brigg Type Indicator (MBTI) to predict academic achievement in the computing sciences has not been widely reported. In effect,

there is not enough empirical evidence as to the role of personality traits in students' academic achievements especially at the tertiary level. This study is a contribution to bridge the gap in literature regarding academic achievements in computing sciences using the MBTI tool.

B. Study Ovjectives

The main objective of this study is to investigate if personality traits do affect academic achievements in computing science. The study also investigates the motivating factors affecting the choice of a career in Computing Science and the reading habits which influence academic achievements in computing science

C. Research Questions

The following research questions are investigated in this study.

- What are the factors that influence students choice of course of study in Computing Science at the University of Botswana?
- Which study habits influence students academic success in the Computing Science at the University of Botswana?
- Which personality traits are high achievers in Computing Science at the University of Botswana?

D. Research Hypotheses

The following hypotheses are tested in this study:

H0: Introverts will have higher academic achievements than extroverts

H1: Introverts will not have higher academic achievements than extroverts

H0: Sensors will have higher academic achievements than intuitives

H1: Sensors will not have higher academic achievements than intuitives

H0: Thinkers will have higher academic achievements than feelers

H1: Thinkers will not have higher academic achievements than feelers

H0: Judges will have higher academic achievements than Perceivers

H1: Judges will not have higheracademic achievements than perceivers

H0: There is significant correlation between personality traits and academic achievements

H1: There is no correlation between personality traits and academic achievements.

The rest of this paper is divided into 6 sections. Section 2 is a review of relevant literature. Section 3 explains the research methodology. Section 4 presents the result of this study with appropriate discussion. Section 5 is the conclusion while section 6 is the list of references

II. Literature Review

Okike[2] investigated the major personality indicators of students Systems Analysts and Designers at the University of Botswana and their performances at System Analysis and Design practical and theoretical examinations. The study suggests that the best achievers in Systems Analysis and Design are students who possess the personality types of Extrovertism (E), iNtuition (N), Feeling (F), Judging (J), Thinking (T), Introversion (I), and Sensing (S). The highest passes in the overall Systems Analysis and Design examination are students with the combined personality traits of Introversion iNtuition Feeling Judging (INFJ), Introversion iNtuition Thinking Judging (INTJ), Extroversion iNtuition Thinking Judging (ENTJ), ExtroversioniNtuition Feeling Judging (ENFJ), and Introversion Sensing Thinking Judging (ISTJ).

Capretz and Ahmed [3] studied the connections between personality traits and the process of software development. The authors mapped soft skills and personality traits to the main stages of the software life cycle. They claim that assigning people with personality types best suited to particular stages of the software life cycle increases the chances of project's successful outcome

Omar and Syed-Abdullah [4] applied rough setsin identifying effective personality type in software engineering teams. It was suggested that a balance of personality types Sensing (S), iNtuition (N), Thinking and Feeling (F) assisted teams in achieving higher software quality. Extroverts (E) in the team also had impacts on team performance.

Da Cunha and Greathead[5] investigated if a specific personality type is correlated with performance on code review task. In their investigation, the researchers measured personality with the Myers Briggs Type indicator(MBTI) while the reviewed code was a Java based 282 lines of code. The subjects of study were 64 second year undergraduate student at New Castle University, UK. To examine the possible links with MBTI type and code review ability, the researchers computed some correlations between task score and each bipolar factor Extrovert-Introvert (EI), Sensing-iNtuition(SN), Thinking-Feeling(TF) and Judging-Perceiving(JP). The result of this study indicated that only a single bipolar within the SN bipolar significantly correlated with code review task, suggesting that people more intuitively inclined performed better than others on code review.

Bishop-Clark and Wheeler [6] investigated the Myers-Briggs personality type and its relationship to computer programming. Specifically, the study sought to know if college students with certain personality types performed better than others in an introductory programming course. The researchers first did a pilot study with 24 students and a follow up study with 114 students. The result of this study showed that sensing students performed significantly better than intuition students in programming assignments while judging students performed better than perception students on computer programs although the results were not significant statistically. In addition, they also noted that although personality may not be an important factor in a student's decision to drop a course, it may influence a student's

evaluation of a class. The researchers concluded that the act of programming (creating and debugging programs) is a feat on its own and should be distinct from scores on written programs.

Similarly, Irani, Telg, Scherler, and Harrington [7] studied the relationship between personality type and distance education students course perception and performance using 39 graduate students of distance education. Perceptions of instructional technique used by the distance instructor were strongly correlated to the students' course grade and overall grade point average for the following personality types: extravert, introvert, intuitive, sensing, feeling, and judging. Of the MBTI type preferences, only thinking and perceiving types showed no significant correlations between course perceptions and performance indicators. Findings from this study indicate that performance outcomes for distance education students may be closely related to course perceptions as a function of personality type preference. Perceptions of instructional technique used by the distance instructor were strongly correlated to the students' course grade and overall grade point average for the following personality types: extravert, introvert, intuitive, sensing, feeling, and judging.

Turley and Bieman[8] studied the attributes of individual software developers in order to identify their professional competencies using biography data and Myers- Briggs Type Indicator (MBTI) and concluded that there was no simple predictor of performance. Although experience variables in their study were related to performance, it could only predict classification of exceptional and non exceptional of 63% of the subjects.

Chung [9] studied the cognitive abilities in computer programming using 523 Form Four secondary school students in Hong Kong. Test administered to the students included mathematics, space, symbols, hidden figures and programming ability. Results of the study suggest that performance in mathematics and spatial tests were significant predictors in programming ability.

III. Study Methodology

This study employs quantitative research methods. A human metric tool (Myers Brigg's Type Indicator, MBTI) and a supportive questionnaire were administered on 60 third year students taking the Bachelor of Information Technology (BSC204), Bachelor of Computing with Finance (BSC 205), Bachelor of Information Systems (BIS 230),Bachelor of Computer Science (BSC280) and Bachelor of Education, Computer Science option (BED 240) programmes of study at the University of Botswana.

The MBTI tool is an automated questionnaire based personality test or human metric tool which reports individual personality trait based on the 16 recognizable traits namely Introversion Sensing Thinking Judging (ISTJ), Introversion Sensing Feeling Judging (ISFJ), Introversion Sensing Thinking Perceiving (ISTP), Introversion Sensing Feeling Perceiving; Introversion iNtuition Feeling Judging (INFJ), Introversion iNtuition Thinking Judging (INTJ), Introversion iNtuition Feeling Perceiving (INFP), Introversion iNtuition Thinking Perceiving (INTP); Extraversion Sensing Thinking Perceiving (ESTP), Extraversion Sensing Feeling Perceiving (ESFP), Extraversion Sensing Thinking Judging (ESTJ), Extraversion Sensing Feeling Judging (ESFJ); Extraversion iNtuition Feeling Perceiving (ENFP), Extraversion iNtuition Thinking Perceiving (ENTP), Extraversion iNtuition Feeling Judgingg (ENFJ), and Extraversion iNtuition Thinking Judging (ENTJ). The MBTI tool classified the 60 students according to their individual personality traits. Furthermore, additional questionnaires were designed in order to gather information from the students concerning what motivated their choice of programme of study at the University of Botswana (UB): BSC 204, BSC 205, BSC 280, BIS 230 and BED 240; as well as how they study in order to understand the various courses they take at the university. In order to measure achievement in the various courses taken by a student, a model was used as follows:

$$y_{ij=}\beta_0+\beta_1 x_{1j+}\beta_2 x_{2j+}\beta_3 x_{3j+}\beta_4 x_{4j+}\ldots\beta_n x_{nj}$$

Where y_{ij} represents a dependent variable, and the independent variables are represented as $\beta_0 + \beta_1 x_{1j+} \beta_2 x_{2j+} \beta_3 x_{3j+} \beta_4 x_{4j+} \ldots \beta_n x_{nj}$. The dependent variable in this study is the achievement (performance or score) in each course taken by a student; the independent variables are the various personality traits exhibited by a student in terms of the level (in percentages) of Extroversion, Introversion, Thinking, Feeling, Sensing, iNtuition, Judging and Perceiving.

The variables which influenced students choice of programme of study: parental influence, personal desire to be in the computing profession, students ability in science and mathematics, students ability in science without mathematics, other reasons; and the variables which indicate student study habit : reading of text books, reading only class notes, reading from online lecture notes (module), use of internet materials, use of university library to read text books and other relevant materials, none use of university library, going to university library to read personal materials; reading class notes, text books and online lecture notes; reading class notes and online lecture materials only because student don't have enough money to purchase recommended text; any other reasons were also considered as independent variable. Data analysis was performed on the data using the Statistical Package for the social sciences (SPSS). Linear regression was done in order to fit the model and justify its significance or none significance at the 0.05 level of significance. Result of regression model was also used to determine the impact of the independent variable on students performance.

IV. Result and Discussion

A. Model Fitting

The model $y_{ij=}\beta_0+\beta_1 x_{1j+}\beta_2 x_{2j+}\beta_3 x_{3j+}\beta_4 x_{4j+}\ldots\beta_n x_{nj}$ was tested for fitness using regression statistic. The result is shown in Table 1 and Table 2. In Table 1, the R square value of 0.431implies that about 43.1% of the predictors explain the variations in the dependent variable. This means that the personality traits contribute to academic achievements of computing science students.

TABLE I. MODEL SUMMARY

Model	R	R Sqr	Adjustd R Sqr	Std Error of the estimate
1	.657[a]	.431	-.032	7.22360

TABLE II. ANOVA

Model 1	Sum of Sqr.	df	Mean Sq	F	Sig
Regrsion	1069.104	22	48.596	.931	.563[b]
Residual	1408.872	27	52.180		
Total	3430.733	59			

a) Dependent Variable: AVGSCORE

b) Predictors:(Constant), PERSONALITY TRAITS, MOTIVATION CHOICE OF STUDY, STUDY HABITS

In Table 2 (ANOVA), the model is not significant. However, considering Table 1, it is clear that 43.1% of the independent variables (predictors) explains the variation in the dependent variable (average score or achievement). This suggests that more information on some other variables are needed to predict achievement in the model

B. Analysis of Students by Personality types

Table 3 below shows the frequency distribution of students by personality types.

TABLE III. DISTRIBUTION OF STUDENTS BY PERSONALITY TYPE

		Frequency	Percent	Valid %
Valid	ENTJ	10	16.7	16.7
	ENFJ	10	16.7	16.7
	ENFP	1	1.7	1.7
	ESFJ	3	5.0	5.0
	ESFP	2	3.3	3.3
	ISFJ	4	6.7	6.7
	ISTJ	4	6.7	6.7
	ISTP	1	1.7	1.7
	INFJ	12	20.0	20.0
	INTJ	12	20.0	20.0
	ISFP	1	1.7	1.7
	Total	60	100.0	100.0

From Table 3, the highest personality traits among this set of students are Introversion iNtuition Feeling Judging (INFJ), Introversion iNtuition Thinking Judging (INTJ), Extroversion iNtuition Thinking Judging (ENTJ) and Extroversion iNtuition Feeling Judging (INFJ)

C. Factors Influencing Students choice of Coputing career

Table 4 shows the frequency distribution of students' response to their motivations for choice of course of studyin computing science.

TABLE IV. MOTIVATIONFORCHOICE OFCAREERINCOMPUTING SCIENCE

Variable	Yes	No	Mean
Parental influence	2 (3.3%)	57 (95.0 %)	60
Desire to be in computing profession	46 (76.6%)	13 (21.7%)	60
Ability in Science and Mathematics	20 (33.3%)	38 (63.3%)	60
Ability in Science , but fair in Mathematics	2 (3.3%)	57 (95.0%)	60
Other reasons	4 (6.7%)	55 (91.5%)	60

From Table 4, the desire to be in the computing profession is the highest motivating factor (76.6%) in choosing a career in computing science followed by students' ability in science and Mathematics (33.3%). Factors such as parental influence (3.3%), being good in science but not in Mathematics (3.3%) do not have a strong influence on students choice of course of study in Computing science. This suggests that ability in Mathematics is a significant predictor of a students probability of choosing a career in the Computing Sciences. Chung [9] also suggested that ability in Mathematics and spartial tests were significant predictors of programming ability and hence programming as a career. Hence, achievements in Mathematics could enhance achievements in Computing Science.

D. Students Study Habits in Computing Science

Table 5 presents students' study habit and understanding their course lectures in computing science at the University of Botswana.

From Table 5, reading class notes, text books and materials posted by lecturers on Moodle (76.6%) and use of Internet related sources (58.3%) are the main study habits of computing science students at the University of Botswana. In terms of students' use of the University library, 33.3 % of computing science students use the library in order to study their personal materials, 23.3% use library book materials while 6.7% of computing science students do not use the library.

TABLE V. STUDENTS STUDY HABITS IN COMPUTING SCIENCE

Variable	Yes	No	Mean
I read my text books	38 (63.3%)	20 (33.3 %)	60
I read my class notes only	14 (23.3%)	43 (71.7%)	60
I read my notes from Moodle only	16 (26.7%)	42 (70.0%)	60
I use only Internet materials	35 (58.3%)	23 (38.3%)	60
I use the library to read text books	14 (23.3%)	43 (71.7%)	60
I don't use the library	4 (6.7)	54(90.0%)	60
I use the library to read personal materials	20 (33.3%)	38 (63.3%)	60
I read class notes, text books & Moodle materials	46 (76.6%)	12 (20.7%)	60
I read class notes and Moodle materials only	0	58 (96.7%)	60
Other reasons	1(1.7 %)	57 (95.0%)	60

Furthermore, it is interesting to note that students' use of Internet based sources (58.3%) is higher than students use of the University library to study personal materials (33.3%), and to use library book materials (23.3%). This suggests that Computing Science students spend more time using Internet based sources than using the University library. This implies that computing science students use the laboratories more than the library.

TABLE VI. ACHIEVEMENT SUMMARY OF NUMBER OF PASSES BY PERSONALITY TRAITS

COURSES \ PERSONALITY & SCORE	**ENTJ**	**ENFJ**	**ENFP**	**ESFJ**	**ESFP**	**ISFJ**	**ISTJ**	**ISTP**	**ISFP**	**INFJ**	**INTJ**
No in class	10	10	1	3	2	4	4	1	1	12	12
Discrete Structure 1 Passes											
50-69%	4	6	1	2	1	2	3	0	1	9	9
70-100%	5	4	0	1	0	0	1	1	0	3	3
Discrete Structure 2											
50-69%	7	7	0	1	1	2	3	0	1	7	7
70-100%	2	3	0	0	0	0	0	1	0	1	3
Algebra											
50-69%	6	6	0	2	1	1	3	1	157		
70-100%	2	3	0	1	0	0	1	0	157		
Programming Principles											
50-69%	9	8	0	3	2	4	4	0	0	9	9
70-100%	1	2	1	0	0	0	0	1	1	3	3
O.O Programming											
50-69%	4	3	1	2	0	1	3	0	2	7	0
70-100%	5	7	0	0	0	1	0	1	1 83		

Data Structures														
50-69%	7	9	1	1	0	3	4	0	07	11				
70-100%	1	1	0	0	0	0	0	1	120					
Data Base Systems														
50-69%	7	3	1	3	2	3	4	1	0811					
70-100%	3	7	0	0	0	1	0	0	14	0				
General Computing (intro)														
50-69%	7	8	1	3	1	2	4	1	1	10	10			
70-100%	2	2	0	0	0	0	0	0	0	1	0			
Total Passes														
No of A's	21	29	1	2	0	2	2	3	52719					
No of Passes	51	50	5	17	8	18	28	3	66264					

E. Achievement of Computing Science students by Personality Type

From Table 6, achievement in 6 core Computing Science courses by personality type is presented. The core courses are taken by students offering Computer Science, Computing with Finance, Information Technology and Information Systems. For the course Discrete Mathematics I, the best students are those who possess personality types ENTJ with 5As, ENFJ with 4As, INFJ with 3As and INTJ with 3As. For Discrete Mathematics II, the best students are of the personality types INTJ with 3As, ENFJ with 3As, ENTJ with 2As, ISTP with 1A, and INFJ with 1A. In Algebra, the best students are students with the personality types INTJ with 7 As, INFJ with 5As, ENFJ with 3As, ENTJ with 2As, ESFJ with 1A, ISTJ with 1A and ISFP with 1 A.

In Programming Principles, the best students are of the personality types INFJ with 3As, INTJ with 3As, ENFJ with 2As, ENTJ with 1A, ISTP with 1A, and ISFP with 1A. In Object Oriented Programming, the best students possess the personality types INFJ with 8As, ENFJ with 7As, ENTJ with 5As, INTJ with 3As, ISTP with 1A, and ISFP with 1A. In Data Structures, the best students possess the personality types INFJ with 2As, ENTJ with 1A, ENFJ with 1A, ISTP with 1A, and ISFP with 1A. In Data Base Systems, the best students possess the personality types ENFJ with 7As, INFJ with 4As, ENTJ with 3As, ISFJ with 1A, and INTJ with 1A. In General Computing (Introduction to Computing), the best students possess the personality types ENTJ with 2As, ENFJ with 2As and INFJ with 1A. For all courses, 'A' grades range from 70% to 100%. Overall results of achievement from Table 6 indicate that the highest number of achievers in a prioritized order are students who possess the personality traits Extroversion iNtuition Feeling Judging (ENFJ) with 29 'A' grades, Introversion iNtuition Feeling Judging (INFJ) with 27'A' grades, Extroversion iNtuition Thinking Judging (ENTJ) with 21 'A' grades, Introversion iNtuitionThinking Judging (INTJ) with 19'A' grades, Introversion Sensing Feeling Judging (ISFP) with 5'A' grades, Introversion Sensing Thinking Perceiving (ISTP) with 3 'A' grades, Introversion Sensing Thinking Perceiving (ISTP) with 3 'A' grades, Introversion Sensing Thinking Judging (ISTJ) with 2 'A' grades, Introversion Sensing Feeling Judging (ISFJ) with 2 'A' grades, Extroversion Sensing Feeling Judging (ESFJ) with 2 'A' grades, and Extroversion iNtuition Feeling Perceiving (ENFP) with 1 'A' grade.

F. Comparisons Between Personality characteristics and Computing Characteristics

a) Characteristics of various types

From [2], the following characteristics of the various personality types were identified:

- Extraversion (E): Focus on the outer world
- Introversion (I): Focus own inner world
- Feeling (F): When making decisions, they look at the people and special circumstances
- iNtuition (N) : Interpret and add meaning to information they taken in
- Judging (J): In dealing with outside, they get things decided
- Thinking (T): When making decisions they first look at the logic and consistency

b) Essential skills of Computing Scientists

Grimson [10] identified four skill set required to study Computer Science namely:

- Computational thinking skill
- Understanding Code
- Understand abilities and limits
- Map Problem into computation.

Capretz and Ahmed[3] on the other hand identified thesoft skills requirements of Systems Analysts, Software Designers, Programmers, Testers and Maintenance engineers and subsequently mapped the skills unto personality types. Some of the identified soft skills include communication skills, interpersonal skills, ability to work independently, being an active listener, having strong analytical and problem solving skills, being open and adaptable to changes, innovative skills, organizational skills, acute attention to details, fast listening skills and team playing skills:

G. Discussion

A careful comparison of Tables 3 and 6 suggests that the dominant personality type among the students are Introversion iNtuition Feeling Judging (INFJ), Introversion iNtuition Thinking Judging (INTJ), Extroversion iNtuition Feeling Judging (ENFJ) and Extroversion iNtuitionThinking Judging (ENTJ). Of the dominant personality types, ENFJ presents the best achievers with 29 'A' grades, followed by the types INFJwith 27 'A' grades, ENTJ with 21 'A' grades, INTJ with 19 'A' grades and ISFP with 5 'A' grades. Overall, the highest passes in the 8 core courses considered in this study are INFJ (89 passes) and INTJ (81 passes) supporting hypotheses 1,3,4, 5 (bullets); ENFJ (79 passes) and ENTJ (72 passes) which nullifies hypothesis 2 (bullet); ESFP(3passes), ISFJ (3passes), ISTJ (3 passes), ESFP (2 passes), ENFP (1), ISTP (1), ISFP (1).

H. Conclusion

In conclusion, the desire to be in the Computing profession is the essential motivating factor in choosing a career in the Computing Sciences (research question 1).

The main study habits which influence students achievement in Computing Science are reading class notes, text books, materials posted on Moodle by lecturers and use of Internet related sources (research question 2). The use of Internet related sources imply that Computing Science students spend more time in laboratories with computers on Internet facilities than in than library reading book sources. Distinctive personality types may enhance academic achievement as well as performance in certain tasks. It is suggested that the best achievers from this study are students who possess the combine personality types ENFJ, INFJ, ENTJ, INTJ (research question 3). Therefore, study concludes that personality traits do affect achievement in Computing Science and especially the traits of Extroversion, Introversion, iNtuition, Feeling, Thinking, Judging, and probably Sensing and Perceiving.

REFERENCES

[1] ACM/AIS/IEEE-CS."Computing Curricular 2005".

[2] E. U. Okike. "Bipolar Factor and Systems Analysis Skills of Student Computing Professionals at University of Botswana, Gaborone," International Journal of Advanced Computer Science and Applications (IJACSA), vol. 5. No. 3, 2014

[3] F.Capretz, F. Ahmed, "Making sense of software development and personality types," ITPro, vol. 12, no. 1 January/February 2010.

[4] M. Omar, and S Syed-Abdullah, "Identifying effective software engineering (SE) team personality types composition using rough set approach," IEEE 2010

[5] D. A. Da Cunha, and D. Greathead, " Does Personality matter? An Analysis of code –review ability," Communications of the ACM. Vol. 50. No. 5, pp. 109-111, May 2007

[6] C. Bishop-Clark and D. Wheeler, "The Myers-Briggs personality type and its relationship to computer programming," Journal of Research on Computing in Education. Vol. 26 Issue 3, pg. 358-371, 1994.

[7] T. Irani, R. Telg, C. Scherler, and M Harrington, " Personality type and its relationship to distance education students' course perceptions and performance," Quarterly Review of Distance Education; Vol. 4 Issue 4, p445, 2003.

[8] R. T. Turley, and J. M. Bieman, "Competencies of exceptional and non exceptional software engineers," J. Systems Software. 28:19-38

[9] C. Chung , "Correlates of problem solving in programming," CUHK Educational Journal Vol. 16. No. 2, pp.185-190, 1986

[10] E. Grimson."Introductory Computer Science Lecture Notes on MIT OpenCourseware,"unpublished