Prediction of Association among Numerical Aptitude, Programming Skills, Trait Emotional Intelligence on Students Performance

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***Abstract*—Identifying variables that predict programming skill may help educators and employers. The employer may select potential students as employees. These variables are influenced by various factors. This paper is an attempt to find these variables. The study evaluated the students on Numerical Aptitude, Object Oriented Programming skills and Trait Emotional Intelligence (TEI). This study also engages the factors like academics, locality and gender to find the skill set of the students in programming. The students were divided into five groups based on trait emotional intelligence variables using the Trait Emotional Intelligence Questionnaire (TEIQue). These variables are wellbeing, self-control, emotionality, sociability and global trait EI. Likert scale was used to measure the TEI factors. In order to explore the relation between these parameters two Data mining techniques (i) Association Rule Mining and (ii) Multilayer Perceptron were applied in the resultant data set. It was found that Strong Numerical knowledge helped the students to achieve higher scores in Programming. This analysis can be used by the educators to improve the students programming skills by improving their numerical ability.**

Keywords- Association Rule Mining, Multilayer Perceptron, TEI, Programming skills, Numerical aptitude.

I. INTRODUCTION

Most people who teach programming believe that programming is closely related to an aptitude for mathematics. This paper tests whether Numerical aptitude of the students with their Trait EI influence their programming ability. The first part tested the Numerical ability of the students with the questionnaire recording the students' demographic details. Student's Numerical aptitude marks were classified into A, B, C, D and F. F denotes failure, below 40 % marks are this category, C denotes Third class, the marks are 40% to 49%. B denotes second class; the marks are 50% to 59%. A denotes first class, the marks are 60% to 74%. D denotes distinction, the above 75% marks. The second part was the trait EI as measured by the Trait Emotional Intelligence Questionnaire (TEIQue) comprised of fifteen distinct facets. It has demonstrated that thirteen of these facets form four interrelated factors: Well-being facets are happiness, optimism, and self-esteem. Self-control facets are emotion control, impulsivity, and stress management. Emotionality facets are emotion-perception, empathy, emotion expression and relationships. Sociability facets are emotion management, assertiveness, and social awareness. Two further facets are adaptability and self motivation feed directly into the global trait EI score [18]. The third part was object oriented programming skills test, which comprised of a questionnaire which tested their OOP skills and the marks were classified similar to the Numerical aptitude test.

The two data mining techniques Association Rule Mining and Multilayer Perceptron were applied in the resultant data sets. The Alpha Miner was used for finding frequent patterns using the Association Rule Mining in the resultant data set. Using Multilayer Perception technique the error measures of MLP classification, confusion matrix, cross-validation were found. In the resultant data set, Multilayer Perceptron technique was applied to find the correctly classified instances, the incorrectly classified instances, the TP Rate, the FP Rate and the ROC values.

This paper is organized as follows. In Section 2 literature review related with Numerical Aptitude, Object Oriented Programming skills, TEI factors and data mining techniques were discussed. Section 3 focuses on the

proposed methodology. Section 4 is about the results of the experiment. Section 5 provides the conclusion of this experiment. Section 6 describes about the acknowledgements. Section 7 explains about references used in this experiment. Section 8 describes about the author details.

II. LITERATURE REVIEW

A. Numerical Aptitude

The mathematical ability can help the students for better understanding of the programming concepts [1]. This paper tested the mathematical aptitude and language aptitude. It was found that the students with good mathematical aptitude understood the logic of the programs in a better manner. The language aptitude gave better understanding of programming knowledge [5]. This study applied correlation between factors influencing programming and found that high mathematical knowledge proved to have better programming skills [3]. The investigation of factors influencing the programming skills proved that students with good problem solving ability exhibited better skills [2] [4].

B. Object Oriented Programming Skills

As there is a paradigm shift from procedural programming to Object Oriented Programming, the student‘s understanding towards the OOPS concept is necessary. This paper attempted to find how students understood the OOPS concepts and showed that there is a need to have a better assessment approach in trying to better understand and facilitate the quality of assessment for OO programming [7]. Applying Association Rule Mining and FP-Tree Growth Algorithm on student database with practical and theory marks found that urban students were better in programming than the rural students [8]. The Trait Emotional Intelligence’s influence on student programming showed that the students with Self Control, Sociability and Well Being were good in OOPS [9].

C. Trait Emotional Intelligence

Trait Emotional Intelligence has become a measure on job market. Rather than IQ in [15] TEI was applied to find out the relation with Students’ Performance. Paper [14] analyzed this and predicted that the students who scored high in trait EI and those who had high personality trait scores performed well academically. In [16] the Questionnaire for TEI was discussed, which can be used to find the students’ traits which influence the programming skills. Various discipline students have different Emotional Intelligence; this was found in [17]. The same concept was applied between creativity index and TEI and their relationship was predicted[18].

D. Associtation Rule Mining

To discover the knowledge on the student database and to find the association with the various factors that influence the programming knowledge Association Rule Mining is needed. This paper concentrated on framing the association rules on the data set [10]. The potential of Association Rule Mining algorithm was tested on student data to recommend a solution for the undergraduate student failures [11].

E. Multi Layer Perceptron

To find the association among the factors such as Numerical Aptitude, OOPS, TEI and Students Performance statistics tools were used in the earlier stages. Now Data Mining classification algorithms are used for this purpose. In [12] Multilayer Perceptron was used to predict the compressive strength of cement mix. Multilayer perception technique provides the classification of confusion matrix result by applying cross-validation. This paper applied this technique on student data to improve the students’ intellectual capability and understanding the subjects. This analysis can be used to predict the students’ academic performance [13].

III. METHODOLOGY

This study was divided into 2 phases. Phase I consists of collecting data related to various variables using different questionnaires. Phase II consists of analyzing the data set by data mining techniques and predicting the results. The detailed pictorial representation of the study is given in Figure 1.

In the I phase, The students demographic details were collected. It contains name, age, locality, gender and academic details. Two tests were conducted to test the Numerical ability, Object Oriented Programming skill of the students through the prepared questionnaire. The Numerical Aptitude test concentrated on calculating percentage, fractions etc., while Programming test concentrated on the questions related to concepts on C++ and Java. The marks for Numerical Aptitude and Programming skills were classified as in table I.

The TEI questionnaire [15] was administered to find the facets of the students. The seven point Likert Scale was used to assess the facets of the students.

Table I. CLASSIFICATION OF NUMERICAL APTITUTDE AND PROGRAMMING SKILLS MARKS

Marks	Classified As
0 - 39	Fail
40 – 49	Third class
50 – 59	Second class
60 – 74	First class
75 – 100	Distinction

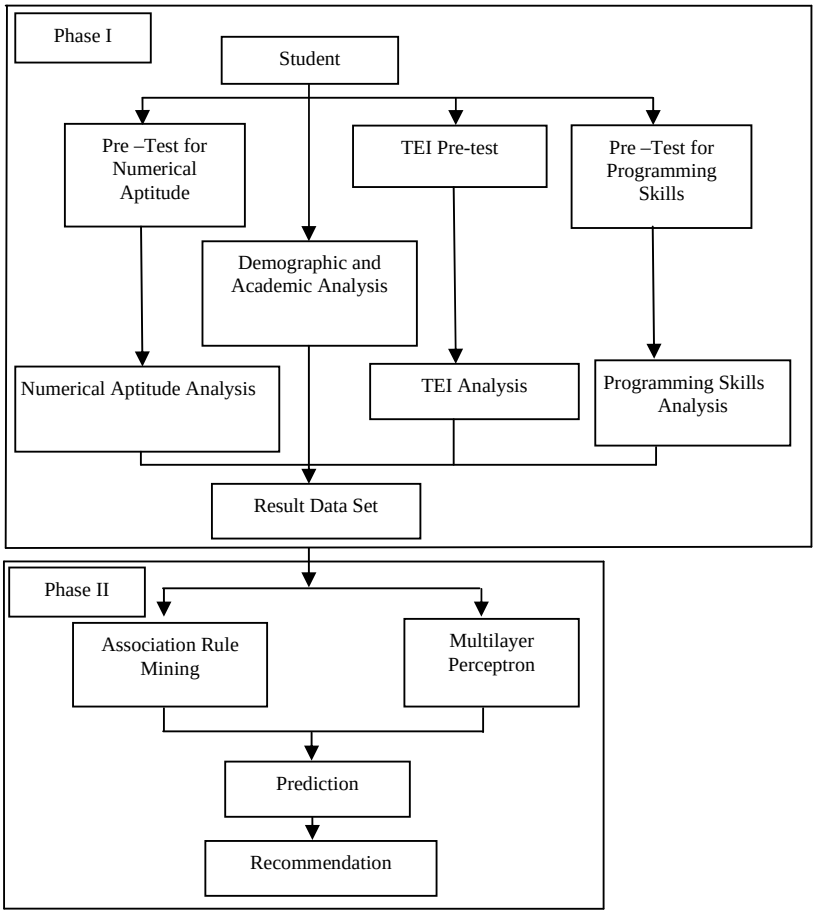

Figure 1. Methdology diagram

The II phase involves the analysis of the resultant data set by applying the data mining techniques such as Association Rule Mining and Multilayer Perceptron. Data mining is extraction meaningful patterns from huge amount of data [6]. To find the relation among Numerical aptitude, Programming skills, TEI, Association Rule Mining was applied. Two main techniques in ARM pruning and joining were also used. In table II item size as 3, support percentage as 13.043 and 100% confidence level was used. The target was Numerical aptitude. To find the error measures Multilayer Perceptron techniques were used. The classification factors for MLP were gender, Academic performance, Locality, Well being, Self control, Emotionality, Sociability, GTEI, Programming skills and Numerical aptitude. The classification of MLP were Kappa Statistics, Mean absolute error, Root mean squared error, Relative absolute error, Root relative squared error.

IV. RESULT AND DISCUSSION

To apply the Association Rule Mining on the resultant data set Alpha Miner tool was used. Similarly Multi layer Perceptron was applied on the data set through Weka tool.

A. Tables

1) Tables II: By applying Association Rule Mining it was found that Female rural students with Global TEI, Sociability Neutral, Well being agree were good in Numerical Aptitude. Also urban Female students with swell

being agree got first class marks. Both Male and Female students who were Emotionally Disagree also got first class marks. Students with Self – Control agree, Global Trait agree had strong Sociability agree. Such students also got first class marks.

TABLE II. ASSOCIATION RULE MINING BASED ON TEI AND NUMERICAL APTITUDE

Rule No	Rule	Item Size	Support(%)	Confidence(%)
30	RURAL, ED => M	3	17.391	100
45	M, EN => F	3	17.391	100
92	A, SD => M	3	17.391	100
93	SD => M, A	3	17.391	100
94	M, SD => A	3	17.391	100
136	RURAL, EN => F	3	17.391	100
140	F, GTD => RURAL	3	17.391	100
141	GTD => RURAL, F	3	17.391	100
142	RURAL, GTD => F	3	17.391	100
159	RURAL, A => F	3	17.391	100
371	A, SN => F	3	17.391	100
380	A, URBAN => F	3	17.391	100
404	WBA, A => F	3	17.391	100
407	WBA, URBAN => F	3	17.391	100
439	SN, GTN => F	3	17.391	100
441	SN, EA => F	3	17.391	100
455	F, ED => GTN	3	17.391	100
60	A, GTA => F	3	17.391	100
523	SA, GTA => A	3	17.391	100
554	SCA, GTA => SA	3	17.391	100
555	SA, GTA => SCA	3	17.391	100
605	SCA, GTA => A	3	17.391	100
704	B, ED => GTN	3	17.391	100

2) Tables III: It was observed from the below table that Male students performed well compared to female students by using Multilayer Pserceptron with detailed accuracy classified as TP Rate, FP Rate, Precision, Recall, F-measure and ROC area. By applying Stratified cross validation it was found that Correctly Classified Instances was 100%. The accuracy details were given as TP Rate (1,1), FP Rate(0,0), Precision(1,1), Recall(1,1), F-measure(1,1) and ROC(1,1).

Table III. CONFUSION MATRIX FOR STUDENTS PROGRAMMING SKILLS GENDER WISE

Classified As	A	B
A = Male	42	0
B = Female	0	27

3) Tables IV: The students accademic performance was classified as A, O, D and B. A means first class, B represents second class, D represents distinction and O represents outstanding. The Correctly Classified Instances for accademic performance was also found to be 100%. The detailed accuracy details for accademic performance were found to be one for all TP Rate, Precision, Recall, F-measure, ROC except for FP Rate.

Table IV. CONFUSION MATRIX FOR STUDENTS ACCADEMIC PERFORMANCE

Classified As	A	B	C	D
A = A	27	0	0	0
B = O	0	3	0	0
C = D	0	0	24	0
D = B	0	0	0	15

4) Tables V: The Correctly Classified Instances for locality was also found to be 100%. The detailed accuracy details for locality were found to be one for all TP Rate, Precision, Recall, F-measure, ROC except for FP Rate.

Table V. CONFUSION MATRIX FOR LOCALITY

Classified As	A	B
A = Rural	51	0
B = Urban	0	18

5) Tables VI: This table describes the programming marks of the students. F denotes failure, A denotes first class and B denotes second class. The Correctly Classified Instances for programming test was also found to be 100%. The detailed accuracy details for programmi were found to be one for all TP Rate, Precision, Recall, F-measure, ROC except for FP Rate.

Table VI. CONFUSION MATRIX FOR MARKS SCORED IN PROGRAMMING TEST

Classified As	A	B	C
A = F	33	0	0
B = A	0	27	0
C = B	0	0	9

6) Tables VII: The performance of students in Numerical Aptitude is classified as F, A, B, C and D. The Correctly Classified Instances for Numerical aptitude was also found to be 100%. The detailed accuracy details for Numerical aptitude were found to be one for all TP Rate, Precision, Recall, F-measure, ROC except for FP Rate.

Table VII. CONFUSION MATRIX FOR NUMBERICAL APTITUDE

Classified As	A	B	C	D	E
A = Fs	9	0	0	0	0
B = A	0	27	0	0	0
C = B	0	0	15	0	0
D = C	0	0	0	9	0
E = D	0	0	0	0	9

7) Tables VIII: In this table WBN represents Well Being Neutral, WBA represents Well Being agree and WBD represents Well Being disagree. From the data it showed that Well Being agree students exhibited high score in Numerical Aptitude. By applying Stratified cross validation it was found that Correctly Classified Instances was 95.6522 and Incorrectly Classified Instances was 4.3478. The accuracy details were given as TP Rate (0.8,1,1), FP Rate(0,0.125,0), Precision(1,0.938,1), Recall(0.8,1,1), F-measure(0.889,0.968,1) and ROC(0.822,1,1) for Well Being Neutral, Well Being Agree, Well Being disagree respectively.

Table VIII. CONFUSION MATRIX FOR TEI'S FIRST FACTOR – WELL BEING

Classified As	A	B	C
A = WBN	12	3	0
B = WBA	0	45	0
C = WBD	0	0	9

8) Tables IX: The second factor of TEI i.e. the Self Control of the students were shown in the following table. SCN denotes Self Control neutral, SCA denotes Self Control agree and SCD denotes Self Control

disagree. The students with Self Control agree performed well in Numerical Aptitude. The Correctly Classified Instances for TEI was found to be 100%. The detailed accuracy details for TEI were found to be one for all TP Rate, Precision, Recall, F-measure, ROC except for FP Rate.

Table IX. CONFUSION MATRIX FOR TEI'S SECOND FACTOR – SELF CONTROL

Classified As	A	B	C
A = SCN	24	0	0
B = SCA	0	33	0
C = SCD	0	0	12

9) Tables X: This table describes the Numerical Aptitude of the students with respect to the third factor Emotionality. Here EN refers Emotionality neutral, EA refers Emotionality agreee and ED refers Emotionality disagree. The students with high Emotionality agree were good in Numerical Aptitude. By applying Stratified cross validation it was found that Correctly Classified Instances was 92.7536 and Incorrectly Classified Instances was 72464. The accuracy details were given as TP Rate (0.867,0.917,1), FP Rate(0.056,0.061,0), Precision(0.813,0.943,1), Recall(0.867,0.917,1), F-measure(0.839,0.93,1) and ROC(0.99,0.993,1) for Emotionality Neutral, Emotionality Agree, Emotionality disagree respectively.

Table X. CONFUSION MATRIX FOR TEI'S THIRD FACTOR – EMOTIONALITY

Classified As	A	B	C
A = EN	13	2	0
B = EA	3	33	0
C = ED	0	0	18

10) Tables XI: The fourth factor of TEI i.e. the Self Control of the students were shown in the following table. SN denotes Sociability neutral, SA denotes Sociability agree and SD denotes Sociability disagree. The students with Sociability Neutral performed well in Numerical Aptitude. The Correctly Classified Instances for TEI was found to be 100%. The detailed accuracy details for TEI were found to be one for all TP Rate, Precision, Recall, F-measure, ROC except for FP Rate.

Table XI. CONFUSION MATRIX FOR TEI'S FOURTH FACTOR – SOCIABILITY

Classified As	A	B	C
A = SN	36	0	0
B = SA	0	21	0
C = SD	0	0	12

11) Tables XII: For the final factor of TEI, Global Trait Emotional Intelligence the classification were GTN, GTA and GTD where GTN denotes Global Trait Neutral, GTA denotes Global Trait Agree and GTD denotes Global Trait Disagree. The GTA class performed well in the Numerical aptitude. The Correctly Classified Instances for TEI was found to be 100%. The detailed accuracy details for TEI were found to be one for all TP Rate, Precision, Recall, F-measure, ROC except for FP Rate.

Table XII. CONFUSION MATRIX FOR TEI'S FINAL FACTOR – GLOBAL TRAIT EMOTIONAL INTELLIGENCE

Classified As	A	B	C
A = GTN	12	0	0
B = GTA	0	33	0
C = GTD	0	0	24

12) Tables XIII: The following table explaines the error measures of MLP classification. The classification are Gender,Accademic performance, Locality, Well being, Self control, Emotionality, Sociability, GTEI, programming test skills and Numerical aptitude. The errors such as Mean absolute error, Root mean square error, Relative absolute error and Root relative squared error. The values of kappa statistics for all the Classification factors shows that there is a excellent relationship between the variables.

Table XIII. ERROR MEASURES OF MLP CLASSIFICATION

Classification Factors	Kappa statistic	Mean absolute error	Root mean square error	Relative absolute error	Root relative squared error
Gender	1	0.0045	0.0057	0.9454%	1.1613%
Accademic Performance	1	0.0114	0.018	3.3273%	4.3631%
Locality	1	0.0076	0.0101	1.9538%	2.2883%
Well Being	0.9115	0.0359	0.1517	10.3661%	36.6596%
Self Control	1	0.0101	0.0142	2.4312%	3.1158%
Emotionality	0.8825	0.0433	0.1413	10.5314%	31.1965%
Sociability	1	0.0094	0.0128	2.3082%	2.8396%
GTEI	1	0.0095	0.0123	2.2858%	2.6938%
Progrmming Test	1	0.0078	0.0105	1.9437%	2.3416%
Numerical Atitude	1	0.0103	0.0152	3.4058%	3.9134%

V. CONCLUSION

This Paper has made an attempt to find the various factors that may influence the programming skill of the Post Graduate students. The factors included for this experiment were students' Numerical aptitude, Student' demographic details, TEI, and Programming knowledge. By applying Association Rule Mining it was found that Female rural students with Global TEI, Sociability Neutral, and Well being agree were good in Numerical Aptitude. Also urban Female students with well being agreed got first class marks. Both Male and Female students who were Emotionally Disagree also got first class marks. Students with Self – Control agree, Global Trait agree had strong Sociability agree. Such students also got first class marks. By applying MLP it was found that students who good in Numerical aptitude were good in Programming. The educators who want their students to be good in programming should also impart the mathematical knowledge to their students.

ACKNOWLEDGMENT

First and foremost, we thank the God for the blessings showered on us. We would like to thank our family, friends, colleagues, the publishers and all those who supported us. Also we thank the students for sparing their time in participating in the tests.

REFERENCES

[1] J. B. H. du Boulay,"Teaching teachers mathematics through programming", International Journal of Mathematical Education in Science and Technology Vol. 11, Issue 3, 1980.
[2] J Valerie J. Shute , "Who is Likely to Acquire Programming Skills?" Journal of Educational Computing Research ,Vol 7, Number 1 / 1991, pp. 1 – 24.
[3] Susan Bergin, Ronan Reilly," Programming: factors that influence success", SIGCSE '05 Proceedings of the 36th SIGCSE technical symposium on Computer science education, ACM New York, NY, USA, pp. 411-415 , 2005.
[4] Lawrence J. Mazlack, "Identifying potential to acquire programming skill", Magazine Communications of the ACM CACM Vol.23 Issue 1, Jan. 1980, pp. 14 – 17.
[5] Vicki L. Sauter, "Predicting computer programming skill ",Management Science/Information Systems, 2002
[6] Jiawei Han and Micheline Kamber, "Data Mining: concepts and techniques", Morgan Kaufmann Publishers, San Francisco, 2006.
[7] K. Elissa, "Title of paper if know Norazlina Khamis and Sufian Idris, "Investigation current object oriented programming assessment method" in Malaysia¨s University, Proceeding of the International Conference on Electrical Engineering and Informatics, Institut Teknologi Bandung, Indonesia June 17-19, 2007.
[8] L. Arockiam et.al, "Deriving Association between Urban and Rural Students Programming Skills", IJCSE International Journal of Computer Science and Engineering, Vol. 02, No. 03, 2010, 687-690.
[9] V. Maria Antoniate Martin, "Evaluation of Object Oriented Programming Skills of Students with respect to Trait Emotional Intelligence based on Students Performance", International Journal of Computer Applications (0975 – 888), Volume 48– No.10, June 2012.
[10] S. Kannan and R. Bhaskaran, "Association Rule Pruning based on Interestingness Measures with Clustering", IJCSI International Journal Of Computer Science Issues, Vol. 6, No. 1, 2009, ISSN: 1694- 0784.
[11] E. Chandra and K. Nandhini, " Knowledge Mining from Student Data", European Journal of Scientific Research, Vol.47, No. 1 (2010), pp. 156 – 163, ISSN: 1450 - 216X
[12] C. Deep, K. SathiyaKumari and V. Pream Sudha, "Prediction of the Compressive Strength of High Performance Concrete Mix Usig Tree Based Modeling", International Journal of Computer Applications (0975 –8887) Volume 6- No. 5, September 2010.
[13] Dhanraj, A. Ramesh and A. Suresh Kumar,"Recommended System for Students Academic Performance based on Personality and Informal Learning", International Journal of Computer Applications (0975 – 8887) Volume 33- No. 7, November 2011.
[14] V. Maria Antoniate Martin, M.Edison and George Gabriel Richard Roy, "An Association between Trait Emotional Intelligence and Personality Trait based on Students Performance", CiiT International Journal of Software Engineering and Technology, March 2012, ISSN: 0974 – 9632.
[15] Natalie L. Shipley, Mary Jo Jackson and Sharon Larisa Segrest, "The effects of emotional intelligence, age, work experience, and academic performance", Research in Higher Educational Journal.

[16] Andrew Cooper, K. V. Petrides, "A Psychometric Analysis of the Trait Emotional Intelligence Questionnaire–Short Form (TEIQue–SF) Using Item Response Theory Journal of Personality Assessment, 2010, Vol. 92(5), pp. 449–457.
[17] Maria Josesa Nchez-Ruiz, Juan Carlos Perez-Gonzalez, K. V. Petrides, "Trait emotional intelligence profiles of students from different university faculties", Australian Journal of Psychology, 2010, Vol. 62, No. 1, pp. 51–57.
[18] M. J. Sánchez-Ruiz, D. Hernández-Torrano, J. C. Pérez-González, M. Batey and K. V. Petrides "TheRelationship between Trait Emotional Intelligence andCreativity Across Subject Domains" Springer, 2011.

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