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1	Multivariate Analysis of Factors Influencing Achievement of
2	Students in Selected Subjects at Secondary School Level: A Case
3	Study of Grade 10 Students at Hawassa City, Ethiopia
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8 Abstract

31

This study has been an attempt to determine factors influencing academic achievements of 9 grade 10 students (normally under age 18 years) on specific subjects. A crosssectional survey 10 was conducted on a total of 719 sample students of grade 10 from 11 different government and 11 nongovernment secondary schools using multistage sampling technique. A designed 12 questionnaire was used to obtain data from the respondents. The secondary data on students 13 EGSECE scores were obtained from the Education Department as achievements of students in 14 the five selected subjects: Mathematics, Biology, Physics, Chemistry and English. Descriptive 15 analysis, factor analysis and multivariate multiple linear regression analyses were used to 16 analyze the data. From the descriptive results both governmental and nongovernmental school 17 students were achieved poorest in physics and best in English. However, on average, 18 nongovernmental school students? achievements were better than governmental school 19 students. In factor analysis, self-concept, motivation to the subjects and teaching-learning 20 process explained most of the variations. Multivariate regression results revealed that, the 21 factors, sex, school type, school facilities, family status, school volume, interest to the subject, 22 motivation to the subject, self-concept, safe reading and trouble (anxiety) to the subjects, had 23 significant influence on achievements of students with respect to most of the subjects. Factors 24 like sex, school facility, family status, motivation to the subject, interest to the subject had a 25 significance positive impact on achievements. However, trouble of the subject and school 26 volume had a significant negative influence on students? achievements on Biology, Physics and 27 English subjects. It is suggested that academic facilities and managements at schools, beside 28 home and students? personal efforts need to be promoted for better academic achievements of 29 students in subjects. 30

Index terms— factor analysis; multivariate multiple linear regression analysis; school subjects; achievement;
 grade ten.

Introduction he current educational system in Ethiopia is organized in cycles or levels of formal schooling that includes ten years of general education. General education is completed at the end of the first cycle of general

secondary school education (Grade 9 and 10). Moreover, this cycle is intended to enable students to identify area

of interest (Natural Sciences Stream and Social Sciences Stream) for further training in the second cycle of general

secondary education (Grades 11and 12) to prepare students for continuing their studies at higher education level
 (University or collages) or selecting their own vocations. Students appear for the New National Examination at

the end of grade 10 (normally under 18 years old) which is known us the Ethiopian General Secondary Education

⁴¹ of Certificate Examination (EGSECE). This is after the students have successfully achieved school examinations

in all school subjects. However, students should score a minimum of 2.00 on a scale of 4.00 in EGSECE or a
 minimum of 50 out of 100 in standard school exams at least in five or seven subjects: English, Mathematics (both

44 compulsory) and any other three or five science (Natural or Social) subjects in order to appear in EGSECE [14].

45 Girls' education is one of the fundamental pillars for ensuring sustainable economic development, democratic

46 participation and poverty reduction. As a result, gender discrimination affects not only women but also the 47 overall growth of the economy. In this connection, the Ethiopian government has given more attention to 48 girl's education. ??n 2003 ??n -2004, due to the favorable policy environment, the gross enrollment of female 49 students at general secondary first cycle (9-10) was about 37.0% and at the preparatory level (11)(12), it was 50 29.0%. Moreover, in technical, vocational and training institutions (colleges), it was 49.0%, whereas it was

25.2% in higher education/Universities. Nevertheless, there was a great variation of students' achievement at
different school type (non-governmental and governmental) based on their gender. Without controlling for student
background differences, nongovernmental schools scored higher than government (public) schools ([4]; [13]).

It is obvious that students at schools can be classified as clever (high achievers), medium (average achievers) and lazy (low achievers) with respect to individual's achievements in specific school subjects based on exam scores or general test results of subjects. The general belief is that, if the student is intelligent or clever, he/she is expected to perform well at school in compulsory and science school subjects and is well fitted for national and regional exams. But intelligence is not the only influential factor of academic achievement in school subjects. In addition to intelligence, there are various factors influencing academic achievement of students at school in each school subjects ([2]; ??19]).

This study has been undertaken to investigate multivariate evaluation of the impacts of family with student and school characteristics variables on academic achievement of students on five selected subjects at secondary schools, specifically in grade 10.

The presence of all or some of the factors identified above may have resulted in the poor academic achievement of students on each school subjects in some areas of our country. However, evidence of the availability of these factors as well as other factors need to be obtained or checked. The purpose of this study, therefore, is to obtain

 $_{67}$ the factors that are responsible for the poor academic achievement of students with school type and gender gap

on school subjects among secondary schools of grade 10 students at Hawassa city, in SNNPR state.

⁶⁹ 1 Statement of the Problem

In 2007/08 the number of students who sat for grade 10 national exams, at SNNPR state, was 92,836 (male
61,742 and female 31,094). Out of these who get CGPA of 2.00 and above out of 4.00 were 33,211 (25,085 males
and 8,126 females). The percent of promoted students in a successive three years, 2005/06, 2006/07 and 2007/08,
were 45.8%, 44.2% and 35.8%. Specifically, the percentage of promoters (scored 2.00 and above) at Hawassa City

Administration in 2007/08 were 46.7 %. [12] Reported that the test items (exam questions) of the EGSECE for
 English were not relatively content valid. Hence, test items did not match with the syllabus contents.

Students might pass from one class level to the other as they evaluated on CGPA result of all subjects. But due to achievement variation with respect to each school subject, students get difficulty and being unsuccessful

in higher level education which leads directionless. The current education system of Ethiopia gives a great
 attention, about 70%, on natural sciences subjects, to enhance sciences and technology. Therefore, it is better
 to find solutions to the problems and factors one faced in his/her academic achievements in selected subjects:

Mathematics, Biology, Physics, Chemistry and English at secondary schools in grade 10 distinctly but dependably.
 Many reasons have been attributed for the high failure rate and poor academic achievements in secondary

schools. Some researchers traced that the high failure rate of students was due to student's inability to comprehend and balanced the principles of some subjects such as Mathematics, Physics and others. Others are of the view that the abysmal school achievement is due to loaded curriculum (there is too much to be taught within a short time) ([8]; [12]).

Again some people suggest it on lack of proper supervision on the part of school administration and family control in student's self-carelessness ([7]; [10]).

Likewise, [13] claimed that gender stereotype and student's interest to the subjects have also great influential effect. Peculiar nature of some factors and the students low and unbalanced success rate have led to this study on the multivariate analysis of the determinants of students' academic achievement measured in five selected subjects at general secondary school completion level, first cycle, grade 10.

⁹³ The following research questions have been developed to guide this study:

$_{94}$ 2 b) Objectives of the Study

The general objective of the study has been to determine the key factors influencing academic achievements of students measured in exam scores of five subjects in grade 10 (Mathematics, Biology, Physics, Chemistry and English), and to assess the variations accounted at school and individual (student) level for each response (school subjects). The Specific Objectives are ? To identify the most important factors (covariates) influencing academic achievements of student's in each component of selected subjects in grade 10. ? To determine the relationship among the school subjects at both school and student level; and whether there is gender and school type differences in this relationship. ? To quantify and determine the within and between schools variation for each components of selected

103 ? To determine the groups or clusters of interrelated observed variables or items as component factors that 104 explain the variation of achievement indictor variables.

105 **3 II.**

106 4 Materials and Methods

¹⁰⁷ 5 a) Description of the Study Area and Population

The study was conducted in Hawassa, the capital city for SNNPR state, which was established in 1960. It is located at about 275 km South West of Addis Ababa, and near to Hawassa Lake. Geographically it lies between 07 0 05 ' Latitude North and 38 0 29 ' Longitude East. According to the report of [6], the estimated population size of the city (urban) in 2007 was 159,013 out of which 81,984 were males and 77,029 females. There are 4 governmental colleges and one university, 8 non-government (private) colleges, 5 governmental high (secondary) schools, about 15 nongovernmental high (secondary) schools. The gross enrollment rate of secondary school students at Hawassa Town Administration has been 62.1%.

The target population for this study was grade 10 students of both government and non-government schools registered in 2010-2011 academic year at Hawassa City secondary schools. The total population of students in all high schools of the city was 6,384 in 2010-2011 academic year.

Exclusion criteria were made on the students who were transferred to other schools or those dropped out, only completed enrolment procedures at the school but did not yet attend the national exam or left the school or had been absent for more than four continuous weeks (excluding school vacations) and had no examination results in 2 of the most targeted school subjects (compulsory subjects). This was because full information about those

122 students was not available.

¹²³ 6 b) Sampling Design and Procedure

A cross-sectional study with stratification sampling designed to take independent samples for different subpopulations was conducted. The stratums were governmental and non-governmental secondary schools as school type.

Sampling methods are scientific procedures of selecting those sampling units which would provide the required estimator with associated margins of uncertainty arising from examining only a part not the whole of the population. The main purpose of stratification is to reduce sampling error. Moreover, stratified sampling is a technique which uses any relevant information that might be available in order to increase efficiency. It involves the division or stratification of a population by partitioning the sampling frame in to non-overlapping and relatively homogeneous groups [5].

A list of grade 10 students was obtained from Hawassa City Administration Education and Capacity Building Department. The population of grade 10 students was stratified into governmental and nongovernmental school and the required sample size for the study was determined from each stratum. The multistage sampling procedure was employed as: The selection of a simple random sample was usually carried out according to a set of mechanical instructions which guarantees the random nature of the selection procedure. This is an equal probability of selecting individual units for all elements in the population of the school.

Stage three: simple random sampling of students from class Taking a list of students with their registration number in each school, then refer to a table of random numbers; the required sample students were selected. In simple random sampling, the selection of one individual was independent of the selection of another individual. i

¹⁴³ 7 . Sample Size Determination

In the planning of a sample survey or researches, a stage at which a decision must be made about the size of the sample is always required. However, too large a sample implies wastage of resources, and too small a sample diminishes the utility of the results. Therefore the decision should be made with a minimum cost but the estimate will explain the population characteristics with a high probability. However, several formulas developed for sample size calculations that conform to different research situations [5].

The sample size for this study was determined based on stratified sampling with proportional allocation at 95% confidence level using the general formula for sample size determination adopted as: The known methods of estimating for calculating sample size of any survey were by taking the sample in two steps; one by the results of a pilot survey and another by previous studies sampling of the same or similar population and guesswork about the structure of the population [5].

But for the present study, and the margin of (absolute) error were determined from the results of previous studies of similar population. The sample variance $2 \ 1 \ s = 0.20885$ and mean = 2.62 were taken for government school from the study which assessed the determinants of students' academic performance in government schools of grade 10 at Hawassa town taking a sample of 920 students (Hanna;. Then, for this study was calculated as: = On the other hand, the sample variance 2.2 s = 0.13421 was taken for non-government schools from the previous study at the same area [11]. The total population was (number of students in 11 selected secondary schools of grade 10) 5006 = N from 5 governmental and 6 non-governmental selected secondary schools, which contained total number of grade 10 students in governmental schools

¹⁶² 8 c) Methods of Data Collection

In assessing the academic achievement of students' measured by exam results scored in school subjects, 163 Mathematics, Biology, Physics, Chemistry and English at both government and non-government sample secondary 164 schools, both primary and secondary data were used. The primary data was collected using questionnaire method. 165 The questionnaire consisted the student's, family background and school characteristic variables on the student's 166 academic achievements evaluated in selected 5 subjects. Individuals sampled for this study were asked to complete 167 the determinants of students' outcome (in five school subjects) study questionnaire. The secondary data on 168 academic achievements of respondents was measured by their? ? = + = 2 1 2 2 1 2 2 1 h h h h h h h h S W N169 170 ? 2 1 h n i hi h n y y h ? = ? = 1 = = ? ? = ? h N i hi h N y h 1 () 2 1 2 1 ? ? = ? = h N i h hi h N Y y S h 171 172 ? N N W h h = 2 h S n 0 n ? = ? ? ? ? ? ? ? ? ? ? 2 1 2 2 2 h h h S W ? N n n n 0 0 1 + = n N N n h h ? ? 173 ? ? ? ?
 = 2 , $1 = {\rm h}$ Year 2016 174

where h = stratum the EGSECE results (scores) in each of the five selected subject (Mathematics, Biology, Physics, Chemistry and English). Besides, school records with regard to students' exam registration number and some profiles of teachers and schools were taken from record offices of the schools. Sampled grade 10 students were taken with their exam scores of all five school subjects and the student's results were standardized and scaled to be 4.00.

¹⁸⁰ 9 d) Variables of Interest in the Research

The outcome variables used in this study were the five selected school subjects as individual's achievement measures using EGSCEE results or scores on the five school subjects (Mathematics, Biology, Physics, Chemistry and English). All achievement scores were taken as standardized and transformed to assure that all scores were scaled in the same metric. This also allowed us to interpret the between school variances as the percentage of variation in student achievement accounted for by schools in PCFA, MVML and multivariate multiple linear regression analysis with respect to each response. The set of explanatory variables included were the composite common factors of students, family, teachers and schools characteristic variables.

i. Students and Family Characteristic Variables These were: Age, gender, religion of student, parents' 188 employment status, natural talent, students' job aspiration, time spent on study, peer(group) effect, student 189 class attendance(absence), skipped class, student's satisfaction with school administration, satisfaction with 190 school rules and regulations, academic confidence, preferred study time, preferred study place, distance of the 191 school from students' home, availability of text and reference books at home, home location, parental involvement, 192 fathers'/guardians' level of education, comfort of study place at home, mothers' education level, average family 193 expenditure, other expenses related to education, satisfactions in food type available in home, pervious grade 194 scores, students attitude and perception on school subjects (difficulty, boringness, preference, etc.). 195

ii. School Characteristic Variables These were: teachers average workload, average year of experience, teachers 196 average educational level, teacher preparation, class size, teaching method, standard of examination, parent to 197 teacher communication, teacher absence, teacher late, average size of school, school fee, completion of the syllabus, 198 school type, student-teacher ratio, teacher efficient and skills, school location/environment, current curriculum, 199 human resources (teachers per subjects, principals, supervisors), infrastructure (buildings, classrooms, sport 200 facilities), library facility, equipment (desks, blackboard, telephone, duplicating computers), amentias (toilets, 201 electricity, water), and availability instructional materials (text and reference books, maps and charts), laboratory 202 facilities, academic counseling service, health service (first aids). 203

²⁰⁴ **10 III.**

²⁰⁵ 11 Methods of Data Analysis a) Factor Analysis Model

This analysis describes the covariance relationships among many variables (items) in terms of a few underlying and unobservable random quantities.

The observable random vector X with P components has mean ? and covariance ?. The factor model postulates that X is linearly dependent upon a few unobservable random variables The factor analysis model is given by: X = LF+ ?, where is a matrix of unknown constants called factor loadings.

²¹¹ 12 L pxm = F= and =

212 The coefficient is the loading of the variable on the factor.

i. Assumptions of Factor Model1. E(F) = 0 = (0, 0, ?, 0) T 2. cov(F) = E(FFT) = Im 3. E(?) = 0 = (0, 0, ?, 0) 4. Cov(?) = E(?, T) = ? pxp, ? is a diagonal matrix 5. Cov(?, F) = E(?, FT) = 0 = (0, 0, ?, 0) T ii.

- 216 22 l m l 2 1 p l 2 p l pm l ? 2 f 1 f m f p ? ? ? 2 1 Year 2016 1. Cov(X) = LL T + 2. Var = , where is the 217 specific factor. ? () i X i im i i l l l ? + + + + 2 2 2 2 1 ... i ? th i 3. 4. () ij j i l F X Cov = , 5.
- 218 , loading matrix.
- 219 Communality is defined by:

The factor model assumes that variables and covariance for X can be reproduced from pm factor loadings and p specific variables .

The factor model provides a simple explanation of the covariation in X with parameters which are fewer than parameters in ?.

²²⁴ 13 iii. Methods of Estimation of Loading

If the off diagonal elements of sample covariance S are small or those of the sample correlation matrix R essentially zero (identity matrix), the variables are not related. This implies that a factor analysis will not prove useful and in these circumstances, the specific factor plays a dominant role. If covariance matrix appears to deviate significantly from a diagonal matrix, then a factor model can be entertained and the initial problem is one of estimating the factor loading and specific variance . There are two popular methods of parameter estimation, Maximum Likelihood (ML) Method and Principal Component Method. However, for this study, the principal component method was used.

²³² 14 iv. The Principal Component Method

The spectral decomposition of covariance ? having eigenvalues-eigenvector pairs with is given as . From the above equation, we can obtain the loading, . I T T TT = =

A useful byproduct of factor analysis was factor scores. Factor scores were composite measures that can be computed for each individual on each common ()km im k i k i k i l l l l l l X X E + + + = ..., 2 2 1 1 () L F X Cov = , 2 2 2 2 1 2 ... im i i l l l h + + + = () () 2 1 2 1 + = ? + p p p p i j l i ? (

 $\begin{array}{c} 240 \\ 241 \end{array}) pm p + () 2 1 + p p ij l i ? () i i e , ? 0 ... + + + = ? ... 2 2 2 1 1 1 = L () S tr S S S pp = + + + ... 22 \\ 241 1 ? ? ? ? = + + + ? ? ? p ... 2 1 ? i ? p i ,...., 2 , 1 = 0 ... 2 1 ? ? ? ? ? ? m ? ? ? ? L pxmpi p i i i ik x \\ 242 l x l x l x l f ? ? ? ? + + + = ... 3 3 2 2 1 1 \end{array}$

243 , where

²⁴⁴ 15 b) Multivariate Multiple Linear Regression Model

The multivariate extension of multiple linear regression was used to model the relationship between responses 245 and a single set of predictor variables. Each of the response was assumed to follow its own regression model, so 246 that ?i r ri i i i i i i z z z ? ? ? ? ? + + + + + = ? ...() = ? × m n = () () m r × +1? = = () m n × ? = = 247 248 ??? ()? = ? Var th j 10? 11?? r 1? 20? 21?? r 2????? 0 n? 1 n?? nr? 11? 12?? m 1? 21?? 249 m 2 ? ??? 1 ? 2 ? ? ? 22 ? () | 1 ? () | 2 ? ? () m | ? 01 ? 02 ? ? m 0 ? 11 ? 12 ? ? m 1 ? ??? 1 r ? 2 r ? ? 250 rm?()()||21???!()m?11?12??m1?21?22??m2???1n?2n??nm?()|1?()|2?? 251 () m? | 252

The multivariate linear regression model is:with 0 = ???????? and ()? $\times = ik$ Cov??? k i , for . 254 ,..., 2 , 1 , m k i =

. Using a matrix ? ?, one can easily ascertain that the matrices of predicted values:? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 260 ? = ? ? ? ? ? ? ? ' 1

261 ? and residuals:

²⁶⁶ 16 Test of Hypothesis

270 , where()()??????????????????????isisES,

$_{271}$ 17 var.

272

²⁷⁹ 18 iii. Checking the Goodness of Fit of the Model

It is imperative to examine the adequacy of the model before the estimated function becomes a permanent part of the decision making apparatus [9]. All the sample information on lack of fit is contained in the residuals.

283 19 iv. Residuals

Since a residual may be viewed as the deviation between the data and the fit, it is also a measure of the variability in the response variable not explained by the regression model. Plotting residuals is a very effective way to investigate how well the regression model fits the data and to check the assumptions.

289 20 . Normal Probability Plot

The most commonly used methods of checking normality of an individual variable are the Quantile-Quantile plot (Q-Q plot), P-P plot and Normal Curve Histogram. The P-P plotted as expected cumulated probability against observed cumulated probability of standardized residuals -line should be at 45 degrees. The variable is normality distributed if this plot illustrates a linear relationship. In case of the assumption that says the combinations of variables follow a multivariate normal distribution, one can generally test each variable individually and assume that they are multivariate normal if they are individually normal [3]; [1]).

vi. Ethical Issue/ Considerations Ethical approval was obtained from research ethics committee of Hawassa University, Postgraduate school of Computional sciences. Following the endorsement by the research ethics committee and acceptance of the postgraduate school and statistics department, Hawassa City Administration Education and Capacity Building Department was informed about the study through a support letter from Hawassa University research Postgraduate research office. Then verbal permission had been obtained from respective department of the city administration.

Following the endorsement by Hawassa City Administration Education and Capacity Building Department, 302 the selected schools were informed about the objective of the study through a support letter from Hawassa City 303 Administration Education and Capacity Building Department and oral permission and supports were obtained 304 from the respected school principals, teachers and students. As the study was conducted through review of 305 academic records, the individual person was not subjected to any harm as far as the confidentiality is kept. 306 Consent was obtained from individual person or student who was selected to fill the study questionnaire. To 307 preserve the confidentiality, data recorders or file keepers, in the City Administration Education and Capacity 308 Building Department extracted the data from the academic records. Moreover, no personal identifiers were used 309 on data collection form. The recorded data was never accessed by a third person except the principal investigator, 310 and was kept with a firm confidentiality in a secured place. 311 IV. 312

313 21 Results

³¹⁴ 22 a) Descriptive Results

From the results in Table 3.1, the average academic achievements of students measured in Mathematics, Biology, 315 Physics, Chemistry and English subjects for non-government school students were, respectively, 2.99, 2.97, 2.50, 316 2.88, and 3.14 with standard deviations 0.822, 0.899, 0.942, 0.806 and 0.805, respectively, and that of government 317 schools were 2.61, 2.73, 2.24, 2.74 and 2.77 with standard deviations 0.838, 0.866, 0.964, 0.872 and 0.802, 318 respectively. Table 3.2 shows the mean academic achievements and the coefficient of variations for the five 319 subjects. In terms of coefficient of variation, the variability was the lowest for English and highest for Physics 320 subjects. This may indicate that students' achievements were most consistent for the English subject and least 321 consistent for Physics subject. Physics was considered as difficult subject for many students. 322

³²³ 23 b) Results of Factor Analysis

Before conducting the central MVML and multivariate multiple regression analyses it is important first to establish the psychometric properties of the instrument used. Principal Component Factor Analysis was done in

two steps. The first one was a general PCFA that considered the socioeconomic and demographic variables with 326 general school characteristic variables and the second was a separate PCFA relative to each achievement measures 327 of the five subjects. This provided component factors for each of the five school subjects each based on the subject 328 related observed items as students' responses on their personal, school and teacher characteristic variables relative 329 to school subjects. The overall reliability was computed to be Cronbach's alpha=0.724 indicating that the 330 questionnaire items were consistent. The KMO statistic values test if sufficient items (by partial correlation 331 among variables) are available for each factor component in the factor analysis. KMO statistic for the separate 332 PCFA with respect to the school subjects Mathematics, Biology, Physics, Chemistry and English were 0.81, 0.77, 333 0.82, 0.78 and 0.84, respectively; with the general PCFA of 0.79. These were all greater than 0.5 indicating 334 that the sampling was adequate for factor analysis and there were significant relationships among the perceived 335 factors of achievements in the school subjects. 336

The data were also checked for Bartlett's test of Sphericity to see that the original variables were sufficiently (bi-variate) correlated and these met the criteria with 0. 11170 These indicated that the original observed variables were sufficiently correlated (the variables were not completely uncorrelated) and factor analysis was possibly appropriate in each case. The output matrixes contained the loading of each variable onto each factor. All loadings less than 0.5 were suppressed in the output and so were blank spaces for many of the loadings. Thus, the loadings were acceptable and easy for interpretation.

343 The results of separate factor analysis (with factor loadings greater than 0.5) are presented in Tables 4, 5, 6, 344 7 and 8 of Appendix-1 and Figures 1 in Appendix-2 of the Scree plots. The criteria that the required amount of explained variation accounted for being large, logical interpretability of factors and Scree plot tests were 345 considered with Kaiser Criteria. Kaiser criteria is accurate when there are less than 30 variables with lager 346 sample and communalities after extraction being greater than 0.6. Depending on the correlation matrix and 347 communalities, some observed variables were rejected. Of all 140 observed items, using principal component 348 extraction and Varimax rotation, the study found factor solution of the 28-variables for each subject. Then, six 349 underlying common factors were obtained for each separate factor analysis of Biology, Physics, Chemistry and 350 English related items that constituted or explained 76.67%, 78.80%, 68.64% and 73.43% of the total variability 351 in the corresponding original observed variables, respectively. There were four common factors for Mathematics 352 related items which constituted or explained 77.38% of the total variability in the original observed variables 353 related to Mathematics. 354

Factor scores of each component factor for each of the 719 individual respondents were computed and these scores were used as data for further analysis. The common factors obtained from the general and separate PCFAs which were used as covariates,

? School facilities (SF), Interest (InterstS) to the subjects, ? Family status (FS), Motivation (MotivS) to the subjects, ? School volume (SV), Trouble (TroubS) to the subjects and ? Safe reading (SafR), Self-concept (SelfC)
to the subjects. ? Loadings Less than 0.5 were suppressed.

³⁶¹ 24 c) Results of Multivariate Multiple Linear Regression Anal ³⁶² ysis

363 Multivariate multiple linear regression analysis was used to examine the effect of independent variables or factors on the outcome variables, i.e. academic achievement in selected subjects. Most of the explanatory variables were 364 the common factors obtained from the general PCFA and some were the regularly appeared component factors 365 in each separate PCFA. The results are shown in Table 3.6. In this analysis the overall determinants of academic 366 achievement were assessed in terms of the five school subjects to identify the basic determinant factors for 367 both government and non-government schools taken together. The factors sex, school type and school facilities 368 (SF) were found to be jointly statistically significant for achievements in all the five selected school subjects. 369 Family status (FS) was significant for achievements in the four school subjects (Biology, Physics, Chemistry and 370 English) but statistically insignificant for achievement in Mathematics. School volume (SV) has a significant 371 influence on achievements in the two school subjects Biology and Chemistry. Interest to the subjects (InterstS) 372 373 has a significant influence on academic achievements of students in Biology and Physics. Moreover, the factors 374 trouble to the subject (TroubS) and motivation (MotivS) to the subject in terms of Mathematics, self-concept 375 (SelfC) in terms of Physics and students future aspiration (FutureAspira) in terms of Physics and Chemistry had 376 significant impact on student's academic achievement as observed in overall combined data of government and nongovernment schools. 377

Moreover, the factors such as sex, interest to the subject (InterstS), motivation to the subject (MotivS), selfconcept (SelfC), family status (FS), school facilities (SF) and future aspiration (Future Aspira) had positive impacts on students' academic achievements of the school subjects. However, trouble (TroubS) of the subjects and school volume (SV) showed significant negative impact on students' achievements of all the five subjects.

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383 26 Discussions and Conclusions

The PCFA technique was used as separate PCFA of items with respect to the each five responses and the general PCFA incorporated other general student with family and school with teacher characteristics variables in the data reduction. The multivariate single level multiple linear regression was applied on overall schools data. The results obtained are discussed as follows:

On an average, students, in non-government secondary schools, performed better than those in government 388 secondary schools in almost all the achievement measures of the five school subjects. This might be because of 389 higher availability of school and home educational supply and facilities, better study positions and higher parental 390 involvement with teachers and students at the schools as compared to that at government schools. Moreover, on 391 overall average, male students achieved better in almost all school subjects than female students. This implied 392 that the school and family might treat gender differently and the variation in students' personal factors such 393 as trouble to the subjects, self-concept, interest and motivation to the subjects showed significant impact on 394 students' achievement ([4]; [6]; ??20]). 395

The results obtained from the separate PCFA in each achievement measuring response indicated that about 396 397 four factors related to Mathematics and six factors related to Biology, Physics, Chemistry and English were sufficient to explain the total achievement variability. Thus, factors self-concept to the subjects, motivation to 398 399 the subjects, interest to the subjects, trouble (anxiety) to the subjects, teaching-learning process and absenteeism explaining most of the achievement variations in five school subjects. Moreover, the result of general PCFA 400 indicated that the factor named as family status (FS) that encompasses parentstudent communication, parent-401 teacher communication, availability of book at home, satisfaction in food available at home, mother educational 402 level and father education level explained the higher variability for the overall achievement. This finding is in 403 consistent with other studies ([13]; [18]). 404

The result of the multivariate multiple linear (single-level) regression analysis point to several interesting 405 overall findings. The result indicated that the factors sex, school type, school facility (SF) which encompassed 406 availability and satisfactoriness of school amenity, human resources, library, laboratory, equipment and academic 407 counseling have significant impacts on achievements of the students in terms of all the selected five subjects. 408 School volume (SV) that encompassed school size, class size, teacher workload and experience had a significant 409 negative impact on academic achievements in terms of Biology and Chemistry. This may be due to the negative 410 effect of school size, class size and teacher work load on academic achievement of students at school, as reported 411 412 earlier ([16]; [17]).

The factor school facility (SF) that deals availability and satisfactoriness of the school instructional materials, school library, laboratories, amenities, academic counseling services and other school characteristics had significant positive impact in all five school subjects used as a measures of academic achievement. Family status (FS) which encompass parent-student communication, parentteacher communication, availability of book at home, satisfaction in food available at home, mother educational level and father education level had a significant positive impact on academic achievements in terms of Biology, Physics, Chemistry and English subjects as observed earlier ([18]; ??19]).

420 This study was intended to identify some factors influencing the academic achievements of students' measured 421 by five selected subjects (Mathematics, Biology, Physics, Chemistry and English) at secondary school level based 422 on primary and secondary data. Accordingly, factor analysis, multivariate multiple linear regression and MVML 423 multiple linear regression techniques on the five school subjects were employed.

The factor analyses conducted in this study indicated that 4 or 6 factors (instead of twenty eight original observed variables or items) were sufficient to explain 77.4%, 76.7%, 78.8%, 68.6% and 73.4% the total variation in achievement for each separate PCFA of observed items related to Mathematics, Biology, Physics, Chemistry and English subjects, respectively. The factors self-concept, motivation, interest and trouble to the subject were the common factors explaining most of the variability of achievements in terms of each five subject, since these factors were appeared regularly in each separate PCFA. Moreover, six common factors were enough to explain about 64% of the variation using 34 originally observed variables in the generalized PCFA.

The study revealed that the factors sex, school type, family status (FS) holding parents-student communication, parent-teacher communication, satisfaction in food available at home, availability of books at home, mother educational level and father education level, and school facility (SF) enclosing school instructional materials, amenities, library and laboratory facilities had statistically significant influence on achievements of students for the selected subjects. Moreover, school volume (SV) that covers school size, class size, teacher work load and teacher experience in teaching; interests to the subject, motivation to the subject, trouble to the subject and self-concept in school subjects have been significant factors

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Figure 1:



Figure 2: (



Figure 3:



Figure 4:



Figure 5:



Figure 6:





Figure 7:



Figure 8:



Figure 9: Appendix- 2 :





 $\mathbf{31}$

School Selected Subject (Hawassa, 2010) Students' Academic Achievement Maths Biology Physics Cherry Type Name

Comboni SOS

		Ν	30	30	30	30
	Adventi	i Mean	2.90	2.77	2.63	2.77
		SD.	0.844	0.817	0.999	0.971
		Ν	29	29	29	29
]	Mount	Mean	2.72	2.55	3.03	2.97
(Olive					
		SD.	.702	.783	.778	.778
Non-		Ν	29	29	29	29
goveri	BNBit	Mean SD.	2.83 .889	2.72 .959	$2.31 \\ .967$	2.79 .726

Figure 11: Table 3 . 1 :

Students

[Note: 2 : Descriptive Statistics Student's Achievement in Ascending Order for the Overall Sample of]

Figure 12: Table 3 .

3

					Year 2016
					35
					Volume XVI Issu
					Version I
					G)
					(
					Global Journal of
					man Social Science
4 : The Generalized Principal Compo	onent F	Factor Ana	lysis (Hawassa, 2010)		
Accounted for 64.28%	1	Common	Factors: Component 2 3 4 5	6	Communality
Eigenvalues	4.56	3.50	2.702.211.65	1.4	5
Variations accounted for $\%$	18.24	4 14.0	10.88.846.60	5.8	0
Parent student communication	.902				0.841

Figure 13: Table 3 .

33

Separate Principal Component I	Factor Analysis	General
ResponsesMaths	Biology Physics ChemistryEngl	ish PCFA

[Note: ?Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.]

Figure 14: Table 3 . 3 :

$\mathbf{35}$

						Responses		
				Mathematics	Biology	Physics	Chemistry	English
R			2	0.72	0.74	0.68	0.68	0.71
R	2	adj		0.64	0.67	0.61	0.64	0.65

Figure 15: Table 3 . 5 :

Parent teacher communication .891			
Satisfaction in food at home	.853	0.767	
Availability of books at home	.840	0.750	
Year 2016			
36			
G)			
Global Journal of Human Social Science -			
S			

Figure 16: Table 3 . 6 :

	fostering proble	em solving skills,	Bahir Dar Univers
29 (1):17 -29.	Ethiopia. Educ	ational Expert, E	Bureau of Education
19. Brian, H. and Russell, K. (2009). LANNA Tests and	Amhara regiona	al State, Ethiopia	ι.
the Prediction of Year 10 English and Mathematics	21. Alan J. Izer	nman (2010). Mo	dern Multivariate
Results: Charles Sturt University, Educational	Statistical Tech	niques: Regressio	on, Classification,
Research, $19(1)$.	and Manifold L	earning.	
20. Alemayehu B., and Assaye A., (2010). An evaluation			
of grades 9 and 10 mathematics textbooks vis-à-vis			
Appendices			
Appendix-1			
Accounted for 77.38%	Common Facto	rs: Components	
	1	$2 \ 3 \ 4$	
Eigenvalues	4.56	3.413.282.67	Communality
% Variations accounted for	25.42	18.9 B 8.1 9 4.84	
Need to do Maths well to get into the University	.905		0.832
The teacher prepares well for Maths daily lessons	.894		0.813
Need to do Maths well to get job	.873		0.782
Learning Maths helps me in my daily life	.845		0.717
Exam questions of Maths are standard	.839		0.726
Teaching Maths covers the whole syllabus	.828		0.692
Often study Maths in groups		.944	0.
			907
Maths is difficult to learn		.912	0.861
No strength in learning Maths		.895	0.810
Need lots of hard work studying Maths to perform well		.894	0.835
Teaching method used by Maths teacher fits with the		.933	0.880
current curriculum			
I am satisfied with the current curriculum of Maths		.921	0.857
Maths need more time to understand		.886	0.809
Maths is Boring		.833	0.729
I usually do Maths well		.898	0.819
Enjoy learning Maths		.874	0.784
I have natural talent in Maths.		.764	0.603
Understand Maths quickly in class		.625	0.568
Extraction Method: Principal Component Analysis. Rot	ation Method: V	arimax with Kais	ser Normalization.

Figure 17: Table 1 :

 $\mathbf{2}$

	International Journal of Educational Development,	
Year 2016 40 Volume XVI Issue II Varsian I		
G)		
(Global Journal of Human Social	Students (Cronbach's ? =0.72, Hawassa, 2010) Accounted for 7	76.65% Common Factors: Compor
Science -	Need to do Biology well to get into the Preparatory or	.907
	University Need to do Biology well to get job	002
	Learning Biology helps me in my daily life	897
	Teacher is efficient and skilled while teaching Biology	.864
	I usually do Biology well	.949
	Understand Biology quickly in class	.911
	Enjoy learning Biology	.900
	S	

Figure 18: Table 2 :

Students (Cronbach's ? =0.71, Hawassa, 2010)

	Common Factors: Comp	onents
Accounted for 78.80%	1 2 3 4 5	6
Eigenvalues	3.903.75 $3.642.861.60$	1.580
% Variations accounted for	17.757.0616.553.07.27	7.18
Need to do Physics well to get job	.898	0
Need to do Physics well to get into the Preparatory or Univer-	.871	0
sity		
Teaching Physics covers the whole syllabus	.850	0
Learning Physics helps me in my daily life	.837	0
I have natural talent in Physics.	.794	0
I usually do Physics well	.967	0
Understand Physics quickly in class	.965	0
Enjoy learning Physics	.964	0
Physics need more time to understand	.956	0
Teacher is efficient and skilled while teaching Physics	.941	0
I am satisfied with the current curriculum of Physics	.940	0
Often study Physics in groups	.929	0
Need lots of hard work studying Physics to perform well	.911	0
Physics is Boring	.977	0
Physics is difficult to learn	.973	0
No strength in learning Physics	.947	0
Physics teacher is often late for class	-	0
	.730	
Student get at least a onetime Physics homework /assignments/	.697	0
class works per week		
Physics teacher often absent from class	-	0
	.688	
Exam questions of Physics are standard		.7780
Teaching method used by Physics teacher fits with the current		.6480
The teacher property well for Druging deily leasers		E E GO
The teacher prepares well for r hysics daily lessons		.000

Figure 19: Table 3 :

$\mathbf{5}$

1 Com 3.66	nmon Factors: Components 2 3 4 5
$16.65\ 16.3$	1 15. 93.0 859
.862	
.857	
.833	
.827	
.784	
.850	
.845	
.844	
.843	
.743	
	1 Com 3.66 16.65 16.3 .862 .857 .833 .827 .784 .850 .845 .844 .843 .743

Figure 20: Table 5 :

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