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Research Article

Multilevel Regression Model Analysis on Determinant of Academic Achievement of Regular Students: In Case of Haramaya University College of Computing and Informatics

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Abstract

This study aims to identify the factors that affect the academic achievement of all undergraduate students of Haramaya University College of Computing and Informatics. Data were obtained from primary and secondary sources. The primary data were obtained by designing a questionnaire on the student-level and department-level variables. Secondary data were obtained from the registrar of Haramaya University College of Computing and Informatics. The research design is a cross-sectional survey that was conducted on a total number of sample 147 students from six different departments using stratified sampling techniques and choosing the students from the departments using a simple random sampling method. The mean and the standard deviation of the Cumulative Grade Point Average (CGPA) of students are 3.05 and 0.44 respectively. A multilevel regression model without explanation and with explanation was applied to analyze the data. After making a comparison between the models, the multilevel regression model with the explanatory variable is the best accounting for 63% variation among six different departments. This indicated that because of high variation between departments, the model is preferred rather than the classical multiple linear regression. The result of the analysis indicated that factors like the economic status of the family, the father's education status, the way of choosing department preference, the assessment and making criteria, and the study hours per day are significant variables. Those significant variables have a positive effect on the academic achievement of students. There was a high degree of variation in academic achievement of students among six different departments rather than within homogenous/similar departments.

Keywords

Academic Achievement, Statistical Modeling, Determinants of Academic Performance, Multilevel Regression Model and Haramaya University

1. Introduction

Higher training establishments play a pivotal role in producing qualified human energy that allows fixing the actual issues of a network [1]. Training is a powerful agent of alternatives that improves fitness and livelihoods and contributes to social balance. At the micro-level, it is associated with higher living requirements for individuals through improved

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productiveness, for the reason that the ones who have acquired better schooling tend to have greater financial and social possibilities. At the macro level, education builds well-informed and professional human capital, which has been taken into consideration as an engine of monetary growth that positively contributes to economic improvement [2]. However, gaining understanding, attitudes, values, and talents via education is not a simple assignment; instead, it is a protracted and hard ride in lifestyles. Students are predicted to spend tons of time reading and ought to graduate with excellent academic effects.

Instructional fulfillment is the volume to which a student, trainer, or group has attained their brief or lengthy-time period academic desires and is measured both by way of continuous evaluation or cumulative grade point common (CGPA). A correlational take look at vocational college students in Indonesia determined that scholars who had desirable educational achievements have higher earnings, better employment advantages, and extra development opportunities [3].

Despite excessive government investment in training, most University students fail to obtain top educational overall performance at all tiers of training. A correlational examination at Arba Minch University, South Ethiopia, mentioned that the trend of graduating university students is not always proportional to the trend of enrolled students and extra students devoted to readmission because of poor educational performance [4]. This led to unemployment, poverty, drug elicit, promiscuity, homelessness, illegal sports, social isolation, insufficient health insurance, and dependence.

Beyond the first-rate University, numerous non-public and family elements, which include socioeconomic elements, English capacity, class attendance, employment, excessive school grades, and educational self-efficacy, have been proposed to influence academic performance. Other factors, i.e., coaching abilities, have a look at hours, family length, and parental involvement have an association with academic success as well (Sothan, 2019). A cohort observed among University students in Australia concluded that growing old does not impede academic achievement [5].

A good-sized association was additionally found between becoming a member of a medical career and appropriate academic performance in Pakistan [6]. At Arba Minch University, students with a great instructional report earlier than campus access are much more likely to have instructional fulfillment in higher schooling programs [7]. A descriptive examination of Bahir Dar University students confirmed that father and mother-attending nightclubs' schooling fame affects instructional performance [8].

One of the important barriers to instructional success is substance use. A cross-sectional look at University students in Wolaita Sodo located that substance use (smoking, khat chewing, drinking alcohol, and having an intimate friend who found uses substances) became appreciably and negatively associated with students' academic overall performance [9].

1.1. Statement of the Problem

The university is one of the locations where systematically prepared and scientifically oriented schooling is offered. It is through such an organized way that the knowledge, abilities, and favored attitudes of the learner broaden, however in a given elegance it is on occasion seen there may be a difference in instructional success because of extraordinary determinants that affect students' academic achievement. The researchers are curious approximately figuring out the relationship between pleasant instructors, family social reputation, peer group, availability of textbooks, analyzing culture, time management, take a look at competence, and so on., and the instructional success of university students subsequently the want for this look at the determinant of academic achievement of university students.

A maximum of the previous researcher's attention is on primary and secondary educational levels and the hassle is not always properly addressed at the University level. The terrible overall performance of university students requires interest. Moreover, in Ethiopia, confined research had been achieved on this subject matter and it was complicated by confounding elements. Therefore, this study intended to identify the predictors of academic achievement of University students in Eastern Ethiopia.

1.2. Basic Research Questions

1) What are the determinates of academic achievement of students undergraduate regular of Computing and Informatics College?
2) How many variations between the departments of computing and Informatics College?
3) Does the linear mixed model fit the data of Academic achievement of computing and Informatics College of undergraduate regular students?

1.3. Objective of the Study

1.3.1. General Objective

The general aim of this study is to determine the factors affecting of academic achievement of Computing and informatics college undergraduate regular students.

1.3.2. Specific Objective

1) To identify the determinant of Academic achievement of computing and informatics college of undergraduate regular students.
2) To determine how much the variation of academic performance between the departments of computing and informatics college.
3) To fit the linear mixed model of Academic achievement

of computing and informatics college of undergraduate regular students.

1.4. Significance the Study

The outcome of this study is significant theoretically because it will help the government through the minister of education and other educational administrators in identifying factors determinants of academic achievement of university students. Education administrators towards increased academic achievement can regulate these determinants. The empirical significance of this study is that it will contribute to the body of literature on the determinants of university students' academic achievement. This study is methodologically significant based on the use of primary information obtained directly from university students. It reveals the factors determining university students' academic achievement as it is currently experienced. The result thereby reveals the recent determinants of university students' academic achievement.

2. Methods and Materials

2.1. Description of the Study Area

This study was conducted in the College of Computing and Informatics College, Haramaya University. The college currently has six different departments: Computer Science, Information Technology, Information Systems, Information Science, Software Engineering, and Statistics. The college is now running a regular undergraduate (a four- and five-year BSc degree). The target population considered in this study is the total number of undergraduate regular students of Computing and Informatics College.

2.2. Source of Data

The source of data for this study is primary data collected from the students and secondary data from the registrar of Haramaya University College of Computing and Informatics.

The target population for this study is the undergraduate students of Haramaya University College of Computing and Informatics.

2.3. Sampling Design and Techniques

The study used a cross-sectional survey with a two-stage stratified sampling design method. The main purpose of stratification is to reduce sampling error due to heterogeneity and take into account the existence of variability among the departments. The stratified sampling technique increases efficiency [10]. In the first and second stages, a sample of regular undergraduate students and the six departments of Haramaya University in the College of Computing and Informatics were considered, respectively. A sample of students was taken from the sampled departments by probability proportional to the academic achievement of Computing and Informatics students. The list of the ID Number and CGPA of undergraduate students from each department was collected from the registrar's office of Computing and Informatics College.

2.4. Sample Size Determination

In conducting a study that requires taking a sample, we always have the stage of deciding the sample size. Taking too large a sample implies a waste of resources and time while too small a sample reduces the usefulness of the results and efficiency. There are several ways of estimating the population variance for sample size determination. These are taking the variance from pilot surveys, previous research work, and guesswork [10]. Accordingly, since we cannot find the population parameters (μ, σ), we can determine the sample size from their estimators by conducting a pilot survey. Using a pilot survey, 30 students were selected randomly from six departments, and the sample size was decided. From the 30 pilot students, the standard deviation of their CGPA is 0.456.

$$n = \begin{cases} n_o, if\ \frac{n_o}{N} < 5\% \\ \frac{n_o}{1+\frac{n_o}{N}}, if\ \frac{n_o}{N} \geq 5\% \end{cases}$$

Where $n_o = \frac{Z^2\alpha/_2 s^2}{d^2} = \frac{(1.96)^2(0.456)^2}{(0.07)^2} = 163.02 = 164$

$$\frac{n_o}{N} = \frac{163.02}{1430} = 0.114$$

$$n = \frac{n_o}{1+\frac{n_o}{N}} = \frac{163.02}{1+\frac{163.02}{1430}} = 146.33 = 147$$

s^2= variance of CGPA of sample students

Z= theoretical value corresponding to the 5% level of significance, set as $Z^2\alpha/_2$ =1.96

d= marginal error determined by the investigator set as 0.07

n= the required sample size,

N= population size

To select the study population from the target population, a stratified random sampling technique is used. Therefore, the population is stratified into six stratums (Stratum1= regular students of the computer science department, Stratum2= regular students of the information technology department, Stratum3 = regular students of the software engineering department, Stratum4= regular students of the Statistics department, Stratum5= regular students of the information system department and Stratum6= regular students of information science department). When the size of the sample from a given stratum is proportional to the size of the stratum, proportional allocation will be used. That is in proportional allocation; a small sample will be taken from a small stratum and a large sample will be taken from a large stratum and the sample size in each stratum will then be added [10].

$$\frac{n}{Nh} = \frac{n}{N} \Rightarrow nh = \frac{n}{N}Nh$$

Where, $N = \sum Nh$ -------- total number of second-year regular Commerce students

nh= Sample size drown from stratum Nh

Nh= Population size in h stratum (in h^{th} department)

n= Total sample size required = $n1+n2+n3+n4+n5+n6$

Population in each department (Nh) and sample drawn from each department (nh) are given below: Population Sample size drawn

$N1$= 405 $n1$=42

$N2$= 400 $n2$=41

$N3$= 400 $n3$= 41

$N4$= 95 $n4$= 10

$N5$= 90 $n5$= 9

$N6$= 40 $n6$= 4

2.5. Data Collection Method

Both primary and secondary data were used for this study. For the randomly selected students, secondary data (CGPA of undergraduate regular students of CCI College) were collected from the Registrar's Office of Computing and Informatics College. Primary data were collected using a designed questionnaire from the students whose secondary data were taken from.

2.6. Dependent Variables

The response variable is the academic achievement of undergraduate regular students of the College of Computing and Informatics and it is measured by the cumulative grade point average (CGPA).

2.7. Independent Variables

Sociodemographic variables: sex, age, family income, father's educational level, and Mother's educational level.

Student Level variables: department preference, study hours, absence from school.

Department-level variables: teachers' commitment to their job, the standard of lectures, and Presentations, assessment and marking criteria, and teachers' interest in the course they have been teaching.

Table 1. *The list and the description of study variables.*

Variable name	Description of Variables	Code of Variables
Sex	Sex of students	0=female, 1= male
Age	Age of students	0=<22, 1=22-25, 3=>26
Family economic status	Economic of family	0=poor, 1=medium, 3=rich
Academic year	Academic year students learn	0=II, 1=III, 2=IV, 3=V
Father education status	The father's education	0=illiterate, 1=literate
Mother education status	The mother's education	0=illiterate, 1=literate
Family occupation	The occupation of the family of students	0=farmer, 1=trader, 3=employment, 4=other
Department preference	The way the student gets department	0=not based on the first choice, 1=based on the first choice
Study hour per day	How much student study per day	0=<3, 1=3-4, 2=>5
Absent of class per week	How many students absent from the class	0=<2, 1=2, 2=>3, 4=none
Teacher commitment to their job	The commitment of teachers to work	0=dissatisfied, 1=satisfied
Standard lecturer presentation	The way to present	0=dissatisfied, 1=satisfied
Assessment and making criteria	The way to evaluate students	0=dissatisfied, 1=satisfied
Teachers interest	The interest of teachers in the work	0=dissatisfied, 1=satisfied

2.8. Method of Data Analysis

The first step in the analysis was to produce descriptive statistics for the department and student-level factors. Linear mixed modeling was used to identify factors affecting students' academic achievement and to distinguish the variation in achievement across departments.

2.9. Multilevel Regression Model

Multilevel models are models that handle data where observations are not independent. LMM can be considered as a further generalization of GLM (General Linear Model) to better support the analysis of a continuous response. Multilevel models include both fixed and random effects. They are particularly useful in settings where repeated measurements are made on the same statistical units or where measurements are made on clusters of related statistical units [11].

Mixed model analysis was first developed for educational research [11]. When analyzing the performance of students, the researchers realized that the observations of students in the same department were not independent of each other. Because standard statistical methods assume independent observations, it is not appropriate to use these methods to analyze the performance of students. The structure of such a study can be described as a sort of hierarchy; students are clustered within a department. Because of this hierarchy, mixed model analysis is also known as hierarchical linear modeling.

This situation is known as a two-level data structure, with the first level being the students and the second level being the department. Because of the different levels, multilevel model analysis is also known as linear mixed model analysis. Again, the general idea of multilevel model analysis in this situation is that it takes into account the dependency of observations, within the department.

The basic principles of multilevel model analysis will be explained by using a continuous outcome variable, i.e. they will be explained using a multilevel model analysis.

The multilevel model is the linear model with a randomly varying subject effect. This subject effect is incorporated in the linear multilevel effects model by regarding it as random, yielding the following models,

Null model: a model in which all explanatory variable is fixed. $Y_{ij} = \beta_o + U_{oj} + \varepsilon_{oij}$

The index I indicate students, j indicates the department U_{oj} is a level two error, ε_{oij} is a level one error, β_o is interpreted as the overall average of academic achievement and Y_{ij} is the academic achievement of i^{th} student in the j^{th} department.

Random intercept model:

$$Y_i = X_i\beta + Z_ib_i + \varepsilon_i$$

Where, $b_i \sim N(0, D)$ $\varepsilon_i \sim N(0, \Sigma_i)$ $b_1, b_2 \ldots, b_N, \varepsilon_1, \varepsilon_2 \ldots, \varepsilon_N$ are, independent

Thus, in the multilevel model, the vector of regression parameters β_i (the fixed effects), are assumed to be the same for all students and have population-averaged interpretations, for example, in terms of changes in the mean response, averaged over all students in the department. In contrast to β_i, the vector bi (when combined with the corresponding fixed effects) is comprised of subject-specific regression coefficients. These are the random effects, and when combined with the fixed effects, they describe the mean response profile of any individual.

Where bi is the random subject effect and the εi are regarded as measurement or sampling errors. In this model, the response for the subject at the level of department is assumed to differ from the population mean, by a subject effect, bi, and a within-subject measurement error, εi. Both the subject effect and the measurement error are assumed to be random, with mean zero, and with variances, Var $(b_i) = \sigma_b^2$; and Var $(\varepsilon i) = \sigma_e^2$, respectively.

2.10. Intra-class Correlation Coefficient

Based on the random intercept variance and the residual variance, the so-called intra-class correlation coefficient (ICC) can be calculated. This ICC is an indication of the average correlation of the observations of subjects living in the same department. The ICC is defined as the variance between departments divided by the total variance, where the total variance is defined as the summation of the variance between departments and the variance within departments [12]. The variance within the department is equal to the residual variance.

$$ICC = \frac{\delta_b^2}{\delta_e^2 + \delta_b^2}$$

Where ICC= intra-class correlation coefficient
δ_b^2 = variance between department
δ_e^2 = variance within the department

3. Result and Discussion

3.1. Multilevel Linear Regression Model Without Explanatory Variables

After checking the normality assumption of the dependent variable, the analysis was done. The results of fitting a multilevel linear regression model without explanatory variables are presented in table 2. The level one and level two variance indicated that department and student differences contributed to the variation in students' cumulative academic achievement.

Table 2. *Results for Multilevel Linear Regression Model without explanatory variables.*

Parameter null model	Estimate	S.E	Z-value	P-value	95%CI
Fixed part					

Parameter null model	Estimate	S.E	Z-value	P-value	95%CI
Intercept (β_o)	3.0097	0.0063	48.12	0.00	2.887, 3.132
Random part: Variance comp					
Level-two variance					
δ^2u=Var(μ_{oj})	0.2043	0.0138			
Level-one variance					
$\delta^2\varepsilon$=Var(ε_{oij})	0.08346	0.0221			
ICC					

Overall fit: LR test vs. linear model: chibar2 (01) = 2.75 Prob = chibar2 = 0.0487

The variances of level two and first levels estimate the variation among departments and students, respectively. By using those variances, we have seen how much the variation between departments and among the students within the same departments. The sources of the variation are both departments and students but the magnitude of variation is different. From the output given above large of the variation in student achievement was accounted for by department differences while a small amount of variation was associated with individual student differences. Also, depending on the empty model the researchers provide an estimate for the intra-class correlation. It is calculated as department-level variances divided by the total variance of student achievement defined as:

$$\text{ICC} = \frac{\delta^2_u}{\delta^2_u + \delta^2_\varepsilon} = \frac{0.2043}{0.2043+0.08346} = 0.63$$

When ICC is large, it means the between-department variance cannot be ignored and therefore a multilevel model is preferred. From the above random effect model $\text{ICC} = \frac{0.2043}{0.2043+0.08346} = 0.63$

Therefore, the multilevel model is the best model for this data. The amount of variation explained by the department is 0.063 (63%), and the amount of variation explained by the student is 0.37 (37%) only. Also, we can conclude that random intercept is incorporated in this model because the overall p-value is less than 0.05.

3.2. Multilevel Linear Regression Model Without Explanatory Variables

As shown in Table 3 below, the multilevel linear regression analysis identifies the effects of explanatory variables in a multilevel regression model with random intercepts and fixed explanatory variables.

Table 3. *Results in Fixed and Random Intercept Linear Regression Model.*

Fixed effect part	Estimate	S.E	Z-value	P-value	95% CI	
Intercept (β_{oj})	2.22224	0.148624	14.95	0.00	1.930748,	2.51334
Sex						
Female	0.02492	0.055687	0.45	0.654	-0.08422,	0.13407
Age						
22-25	-0.0270	0.069195	-0.39	0.696	-0.16266,	0.10857
>26	0.42896	0.136123	3.15	0.002	0.162167,	0.69576
Family Economic Status						
Medium	0.23958	0.076397	3.14	0.002	0.089846,	0.38932
Rich	0.36192	0.126453	2.86	0.004	0.114079,	0.60976
Academic Year						
III year	0.23637	0.092060	2.57	0.01	0.055935,	0.41680
IV year	0.34597	0.102594	3.37	0.001	0.144888,	0.54705

Fixed effect part	**Estimate**	**S.E**	**Z-value**	**P-value**	**95% CI**	
V year	0.05574	0.103812	0.54	0.591	-0.14772,	0.25921
Father education Status						
Literate	0.17446	0.078521	2.22	0.026	0.020567,	0.32836
Mother educational Status						
Literate	0.09809	0.069095	1.42	0.156	-0.03733,	0.23351
Family occupation						
Trader	0.02876	0.074942	0.38	0.701	-0.11811,	0.17564
Employment	-0.1490	0.079539	-1.87	0.061	-0.30494,	0.00684
Other	-0.2262	0.231851	-0.98	0.329	-0.68065,	0.22818
Department Preference						
based on your first choice	0.42589	0.072754	5.85	0.000	0.283296,	0.56849
Study Hour Per Day						
3-4 per day	0.11797	0.064365	1.83	0.047	-0.00817,	0.24413
>5 per day	0.11631	0.10925	1.06	0.287	-0.09781,	0.33043
Absent of the School Peer Week						
two day	-0.0283	0.078008	-0.36	0.716	-0.18126,	0.12452
>3 day	0.03036	0.095245	0.32	0.75	-0.15631,	0.21703
None	-0.1108	0.084638	-1.31	0.19	-0.27669,	0.0550
Teacher Commitment to their job						
Satisfied	-0.0666	0.060863	-1.09	0.274	-0.18589,	0.05268
Standard Lecturer Presentation						
Satisfied	-0.0263	0.057570	-0.46	0.648	-0.13915,	0.08651
Assessment and Making Criteria						
Satisfied	0.11054	0.054067	2.04	0.041	0.004570,	0.21651
Teachers Interest						
Satisfied	-0.0007	0.05899	-0.01	0.99	-0.11634,	0.11491
Random –effect						
Department level						
$\delta^2u=Var(\mu_{oj})$	0.0125					
Student Level						
$\delta^2\varepsilon=Var(\varepsilon_{oij})$	0.1851					

Based on the likelihood ratio test full model is preferred over than null model. G^2 =-2log (likelihood of null model) - (-2log (likelihood of full model)) = 2*87.222043-2*31.215068=112.01 with p=0.00 (p<0.05). This indicated that the multilevel regression model with an explanatory variable is preferable to the multilevel model without the explanatory variables.

From the above Table 3 the economic status of the family, the father's education status, the way of the choice department, the assessment and making criteria, and the study hour 3-4 per day are the significant variables. The mean CGPA of students whose family economic state is medium and rich is 0.23958 (95% CI: 0.089846, 0.38932) and 0.36192 (95%CI: 0.114079, 0.60976) more than the students whose family is poor respectively. The mean CGPA of the father's student literate is 0.17446 (95% CI: 0.020567, 0.32836) more than the students whose fathers are illiterate. The mean of CGPA students who

got a department based on their first choice is 0.42589 (95%CI: 0.283296, 0.56849) more than the students who did not prefer the first choice as the best. The mean of CGPA students who are satisfied with assessment-making criteria is 0.11054 (95%CI: 0.00457, 0.21651) more than those not happy with assessment-making criteria. The mean of CGPA students who study 3-4 hours per day is 0.11797 (95%CI: -0.00817, 0.24413) more than the students who study less than 3 hours per day.

4. Discussion

A large number of things play a role in University students' academic achievement. Therefore, it isn't always easy to pick out these factors given their numerous nature [13] or the complex associations among them [14]. To better understand this phenomenon, researchers in the field have addressed it extensively through the usage of various fashions and statistical tactics [13]. The prevailing systematic assessment is meant to update the literature on the determinants of academic achievement among the general student population from center to University level, a length at some point of which more attempt and investment are important to promote advantageous and adaptive faculty pathways. The economic status of the family, the father's education status, the way of the choice department, the assessment and making criteria, and the study hour 3-4 per day are the significant variables. The mean CGPA of students whose family economic state is medium and rich is 0.23958 (95% CI: 0.089846, 0.38932) and 0.36192 (95%CI: 0.114079, 0.60976) more than the students whose family is poor respectively.

Tries were made to observe the extent of the contribution of variables on the pupil degree, family socioeconomic status, and school status for the instructional achievement of university students. The analysis is executed by getting into variables at every stage hierarchically to see the relative importance of variables at every stage. As a result, in this case, University students' houses became extensively predicting students' educational fulfillment. As a result, University students who live in city areas outperformed university students in their counterparts. There have been dozens of studies, which go in keeping with the locating of the present-day look at. [15-17] found out that urban residency University students are better at academic success than rural residency students.

5. Conclusions

The main objective of this study is to identify the significant factors that affect the academic achievement of Haramaya University College of Computing and Informatics students. Researchers used primary and secondary data for this study and applied the multilevel regression model with the explanatory and without explanation. After a comparison between the null and full model of the multilevel model, there is a significant difference between the null model and the full model. Therefore, for this study multilevel regression model with explanatory variable is a preferred model. In addition to this, there is higher variation between departments than the student variation within the same departments. The variation among departments is 0.63 (63%) and the left variation is the variation that comes from the students 0.37 (37%) only. This indicated that the multilevel model is appropriate and accounts for the variation among departments.

The estimation parameters used in this study is the maximum likelihood estimation parameters method. The significant factors that affect the academic achievement of the students are the economic status of the family, the father's education status, the way of choice department preference, the assessment and making criteria, and the study hours 3-4 per day are the significant variables.

6. Recommendations

From the results obtained in this study significant variables that affect the academic achievement of students were identified by the multilevel regression model. Depending on that factor the recommendations are made for a government body, family, education organization, community group, and students as follows:

1) The government, parents, educational organizations, and students should provide great attention together to improve the academic achievement of students.
2) Parents and governments should help the students by buying something important for education like computers and other materials.
3) The students should increase the time of their study per day by at least three hours.
4) The students must learn the course/department of their interest rather than the interest of other people or the interest of family.
5) The teachers should follow the guidelines of assessment and making criteria of the university.

Abbreviations

GLM	General Linear Model
CGPA	Cumulative Grade Point Average
CCI	College of Computing and Informatics
LMM	Linear Mixed Modeling

Author Contributions

Moti Gelata Sakata: Conceptualization, Investigation, Methodology, Project administration, Resources, Visualization, Writing – original draft, Writing – review & editing

Gemechu Asfaw Zewude: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Software, Validation, Visualization

Conflicts of Interest

The authors declare no conflicts of interest.

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Research Field

Moti Gelata Sakata: Educational psychology, Social psychology, Learning psychology, Cognitive psychology, General psychology, Active Learning

Gemechu Asfaw Zewude: Biostatics, Statistics, Survival Analysis, Longitudinal Data Analysis, Epidemiology