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THE RELATIONSHIP BETWEEN STUDENTS' BIOLOGY LABORATORY SKILL PERFORMANCE AND THEIR COURSE ACHIEVEMENT

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Abstract

The focus of this research study was to investigate the relationship between students' prior achievement in higher education entrance examination score and their course achievement in undergraduate biology program. It also examined the relationship between students' high school and college preparatory school biology laboratory experience and their undergraduate biology laboratory skill performance. A correlational study was used. The sample consisted of 55 third year undergraduate biology students. The findings of the study showed that there is significant and positive linear correlation between students' competences in practical skills and performance in higher education entrance examination scores. There is a significant and a positively linear relationship between the students' cumulative grade point average (CGPA) with higher education entrance exam scores and biology laboratory skill test score. However, laboratory skill performance test score was not correlated with students' high school laboratory background and sex. The findings implicated that the Ministry of Education should foster secondary high schools and college preparatory schools to put greater efforts at preparing undergraduate admitted students for students' better outcome and their retention in universities.
Key words: *high school achievement, practical skill test, undergraduate biology.*

Introduction

Higher education admission officials typically use higher education entrance examination scores on university entrance to predict an applicant's probability of academic success in the universities. Moreover, employers use cumulate grade point average of the students as main selection criteria. Research studies show that undergraduate students' performance depends on many factors such as availability of learning resources, gender, age, socioeconomic status of the students, influence of peers and academicians (Hansen, 2000). Yet, there is little evidence on the relationship between students' theory and practical skill performance. A study conducted by Uwaifo (2012) showed that there is a statistically significant relationship between students' theory and practical performance scores. Aina (2014) reported that there are significant differences between students' performances in physics theory and practical; between female Physics theory and practical and also between male Physics theory and practical.

On the other hand, research findings showed that there is no relationship between students' achievement in theory and practical work scores (Achor, Kurumeh & Orokpo, 2012;

Nawaz, Mahmood & Rana, 2004). Akanbi and Usman (2014) showed also that there is no relationship between physics student performance in micro-teaching and that of teaching practice.

Several studies have been carried out to examine the relationship between students' high school background and university course achievement. But there is still a debate among researchers. For example, Sadler and Tai (2001) have shown that high school physics course has a positive relationship with the grade earned in introductory college physics. Karemera (2003) showed that high school achievement is significantly correlated with college performance. A study conducted by Tai, Sadler, and Loehr (2005) to examine the link between high school chemistry pedagogical experiences and performance in introductory college chemistry showed that several high school pedagogical experiences are linked with varying levels of performance in college chemistry. Noble and Radunzel (2007) stated also that academically underprepared students have to spend more time and money taking remedial courses in college, earn lower grades and have lower retention rates. Adeyemi (2008) showed also that the junior secondary certificate examinations were a good predictor of performance at senior secondary certificate examination. Moreover, Falicoff, Castiñeiras and Odetti (2014), conducted a study to assess the science competency of first year university students enrolling in the school of biochemistry and biological sciences and examine the effects of these courses on their competencies of chemistry proficiency. The results indicated that first-year students started with a low performance level for all the sub-competencies assessed and performance levels on using scientific evidence decreased.

Sawyer (2008) found that high school course work and high school grades are related to achievement test (ACT) scores and encouraging students to take more rigorous college-preparatory courses help to earn higher grades in these courses. Bone and Reid (2011) reported that students who completed biology at the senior high school-level did perform better than those who had not. Clark (2011) showed that taking higher level science coursework in high school is also positively associated with final grade. Taking more semesters of higher level science coursework does not increase the likelihood of doing well in college chemistry, as there is no observable significant influence on final grade in chemistry.

Loehr, et al. (2012) studied the association between students' high school science education and mathematics experiences with introductory college biology the final course grade in introductory biology courses. The result showed that advanced high school science and mathematics coursework was positively associated with students' achievement in introductory college biology.

On the other hand, Wang (2009) claimed that there is little connection between mathematical educational knowledge and the educational background. Tai et al. (2005) stated that overemphasis on laboratory procedure in high school chemistry was associated with lower grade in college.

There is also a debate that practical skill test scores varies among sexes. For example, Ochonogor (2011) showed that there is a significant difference in performance level between male and female undergraduate biology students in that the female students perform significantly better than the males. However, Achor et al (2012) showed that male and female students' performance in a test of theoretical knowledge in Chemistry does not significantly predict their performance in Senior Secondary Certificate Chemistry theory examination. Jack (2013) argues also that sex does not influence students' acquisition of science process skills.

However, none of the studies have examined these variables to determine the relationship between undergraduate biology students' prior secondary and college preparatory school biology laboratory background and their undergraduate laboratory skill performance. Hence, it is important to establish if there is correlation between prior background in biology laboratory at secondary and preparatory schools and the biology laboratory skill performance test scores.

This study, therefore, investigates the relationship existing between students' biology laboratory skill performance and their course achievement in undergraduate biology program.

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It also examines the relationship between high school laboratory experience and their undergraduate biology laboratory practical skill performance at undergraduate level.

Research Questions

1. Does students' prior achievement in higher education entrance examination score relate to their course achievement in undergraduate biology program?
2. What is the relationship between high school laboratory experience and undergraduate biology laboratory practical skills?

Methodology of Research

Research Design

A correlational research design was used for this study. A correlational research design was appropriate because the study aims to examine the relationship between two quantitative variables in order to explain or predict the results (Creswell, 2008). The independent variable included students' prior achievement in higher education entrance examination score, sex and high school preparatory laboratory experience and maximum number of laboratory session they took. The dependent variables are students' course achievement in undergraduate biology program and students undergraduate laboratory skill performance test scores.

Data Collection Instrument

The data were collected using laboratory practical task test developed by the researchers and questionnaires from the sample of third year biology students in three universities to test whether students' prior high school laboratory background, students' higher education entrance examination scores, and their sex, (independent variables) relate to the students' laboratory practical skill performance test score and students cumulative grade point average (dependent variables).

Sampling Technique

The research was conducted with sample of 55 students (32 male and 23 female students) randomly selected from a total of 208 third year biology undergraduate students from three governmental universities. The universities have different length of work experiences and recourses. Third year biology students were selected as samples of the study because they had already completed their intended laboratory works.

Instruments

The student course achievement in undergraduate biology program was measured by cumulative grade point average (CGPA). Researchers around the world used the CGPA to measure the student course achievement (Galiher, 2006; Darling, 2005). They used CGPA to measure student performance in particular semester. The research method for this study encompasses laboratory practical skill performance test for the third year biology undergraduate students. Students' prior achievement of higher education entrance examination score obtained from students self-report before performing the laboratory practical skill performance test.

Individual laboratory practical skill performance test was implemented to 55 randomly selected third year students from the selected universities. It was designed with a specific strategy to assess three core manipulative laboratory skills: identifying the basic biology laboratory equipment, accurate and precise use of light micropipette and measuring weights and volumes.

The three laboratory skills were selected for the reason that they are the basic and minimum laboratory practices for undergraduate biology students. The students' laboratory practical skill performances were assessed by a rubric. Every student was evaluated by two raters. The raters were all biology instructors, who were trained by the researcher for two hours how to evaluate the performance of each student and how to use the rubric.

Validity and Reliability of Instrument

Prior to administration, the laboratory practical skill performance test was submitted to a group four biology professors for an assessment of its content validity. The purpose of the content validation was to get the draft item moderated so as to be reliable.

To test the reliability of the laboratory practical test rating rubrics, the inter rater agreement was computed by the Spearman correlation coefficient as shown in Table 1 below, rho=0.86 which is significant (p=0.000) at the 0.01 level and the intra-class correlation coefficient between raters was 0.94.

Table 1. The inter rater agreement correlation coefficient and the intra-class correlation coefficient.

			Rater 1	Rater 2
Spearman's rho	Rater1	Correlation Coefficient	1.000	0.858**
		Sig. (2-tailed)	.	0.0001
		N	55	55
	Rater2	Correlation Coefficient	.858**	1.000
		Sig. (2-tailed)	0.0001	.
		N	55	55

**. Correlation is significant at the 0.01 level (2-tailed).

Data Analysis

The collected data were transferred into the SPSS data file. Pearson correlation was used to determine whether there was a significant relationship (association) between the independent variables and students' laboratory practical skill performance. One way ANOVA was used to compare the students' performance test scores of various activities who performed basic biology laboratory skill performance test in the universities. Multiple Regression analysis with linear function was used to find out the differential impact (causal-relationship) between third year biology under graduate students' cumulative grade point average (CGPA) and various potential predictors such as sex, high school background, higher education entrance examination score, and number of laboratory sessions they conducted.

Results of the Research

The Relationship between Higher Education Entrance Exam Scores and Undergraduate Students' Course Achievement

An examination of the results of the Pearson's correlation analysis (Table 2) revealed that cumulative grade point average (CGPA) is positively and significantly correlated with higher education entrance exam score and biology laboratory test scores but not with sex and prior high school and preparatory biology laboratory background.

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Table 2. Results of the Pearson's Correlation matrix CGPA and Laboratory skill performance activities test score.

		Sex	Higher education entrance exam score	Cumulative CGPA	High school lab background	Biology laboratory skill test score
Sex	Pearson Correlation	1	-0.042	-0.150	0.314*	-0.192
	Sig. (2-tailed)		0.762	0.274	0.020	0.160
	N	55	55	55	55	55
Higher education entrance exam score	Pearson Correlation	-0.042	1	0.464**	-0.049	0.372**
	Sig. (2-tailed)	0.762		0.000	0.725	0.005
	N	55	55	55	55	55
cumulative CGPA	Pearson Correlation	-0.150	0.464**	1	-0.079	0.546**
	Sig. (2-tailed)	0.274	0.0001		0.565	0.0001
	N	55	55	55	55	55
High school biology laboratory background	Pearson Correlation	0.314*	-0.049	-0.079	1	-0.143
	Sig. (2-tailed)	0.020	0.725	0.565		0.297
	N	55	55	55	55	55
Biology laboratory skill test score	Pearson Correlation	-0.192	0.372**	0.546**	-0.143	1
	Sig. (2-tailed)	0.160	0.005	0.0001	0.297	
	N	55	55	55	55	55

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

An examination of the results of the Pearson's correlation analysis (see Table 3) revealed that there is a significant and a positively linear relationship between the students' CGPA with some of laboratory skill performance test scores, such as with identification of lab equipment (ILE), handling of microscope(HM), setting of microscope(SM), estimation of diameter of field of vision(EDFV), measuring liquid(ML) but not correlated with some of lab skill performance activities such as function of lab equipment(FLE), mounting (M),staining, focusing, drawing and measuring weight(MW). There is a significant relationship between higher education entrance exam score (HEEES) and cumulative grade point average ($p<0.009$).

Table 3. Results of the Pearson's Correlation Analysis of CGPA and Laboratory skill performance activities test score.

N=55	Correlation r (correlation coefficient	p significance level
CGPA-ILE	0.362	0.009*
CGPA-FLE	0.204	0.152
CGPA-HM	0.312	0.026*
CGPA-SM	0.363	0.006*
CGPA-M	0.150	0.293
CGPA-Staining	0.057	0.094
CGPA-Focusing	0.213	0.133
CGPA-EDFV	0.000	0.000*
CGPA-Drawing	0.231	0.107
CGPA-ML	0.283	0.044*
CGPA-MW	0.254	0.072
CGPA-HEEES	0.458	0.009*

*Correlation is significant at the 0.05 level

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The Relationship between Undergraduate Biology Laboratory Practical Skills Performance and Independent Variables Such as High School Laboratory Background

There is a significant correlation between higher education entrance exam score (HEEES) and laboratory skill performance activities test score ($p<0.005$). However, biology laboratory skill test score is not significantly correlated with sex and prior high school and preparatory school biology laboratory background.

Table 4. One way ANOVA analysis of students' performance test scores of various activities among universities.

		Sum of Squares	df	Mean Square	F	Sig.
Identification of laboratory equipment	Between Groups	41.310	2	20.655	2.236	0.117
	Within Groups	480.326	52	9.237		
	Total	521.636	54			
Function of laboratory equipment	Between Groups	77.306	2	38.653	4.695	0.013*
	Within Groups	428.076	52	8.232		
	Total	505.382	54			
Handling of microscope	Between Groups	32.378	2	16.189	21.310	0.0001**
	Within Groups	39.503	52	0.760		
	Total	71.882	54			
Setting of microscope	Between Groups	19.203	2	9.602	18.395	0.0001**
	Within Groups	27.142	52	0.522		
	Total	46.345	54			
Mounting of specimen	Between Groups	23.668	2	11.834	18.174	0.0001**
	Within Groups	33.859	52	0.651		
	Total	57.527	54			
Staining of specimen	Between Groups	1.941	2	0.971	.818	0.447
	Within Groups	61.668	52	1.186		
	Total	63.609	54			
Focusing of a microscope from low to high power objectives	Between Groups	8.808	2	4.404	8.939	0.0001**
	Within Groups	25.619	52	0.493		
	Total	34.427	54			
Estimation of diameter of field of vision	Between Groups	.000	2	0.000	a.	.a
	Within Groups	.000	51	0.000		
	Total	.000	53			
Drawing of specimen seen in the microscope	Between Groups	8.922	2	4.461	9.320	0.0001**
	Within Groups	24.411	51	.479		
	Total	33.333	53			
measuring liquid in litre, ml and µl	Between Groups	9.658	2	4.829	6.604	0.003**
	Within Groups	38.024	52	0.731		
	Total	47.682	54			
measuring weight in gm, mg and µg	Between Groups	7.436	2	3.718	6.957	0.002**
	Within Groups	27.791	52	0.534		
	Total	35.227	54			

**Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

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Correlation and multiple regression analyses were conducted to examine the relationship between third year biology under graduate students' cumulative grade point average (CGPA) and various potential predictors such as sex, high school background, higher education entrance examination score, and number of laboratory sessions they conducted. The multiple regression model with all four predictors produced $R^2 = .189$, $F(4, 163) = 9.257$, $p < .000$. As can be seen in Table 5, sex is negatively correlated with the third year biology under graduate students' CGPA (coded as 0=Male and 1=Female), indicating that the male students have a larger CGPA. Moreover, high school background is negatively correlated with students CGPA. Higher education entrance examination score and number of laboratory sessions they conducted had significant positive regression weights, indicating students with higher scores on these scales were expected to have higher GPA.

Table 5. Multiple regression model summary of the predictor variable.

	Unstandardized Coefficient		Standardized Coefficient			Collinearity Statistics	
	B	Std. Error	Beta	T	Sig.	Tolerance	VIF
Constant	2.104	0.267		7.878	0.000		
High school laboratory background	-0.064	0.036	-0.127	-1.754	0.081	.980	1.021
Sex	-0.231	0.078	-0.214	-2.945	0.004	.969	1.032
HEEES	0.003	0.001	0.291	4.041	0.000	.981	1.020
Maximum number of laboratory session	0.027	0.018	0.111	1.551	0.123	.989	1.011

a. Dependent Variable: CGPA

Discussion

The results of the study have shown that gender has no significant effect on students' biology laboratory performance test scores. The laboratory performance skill tests used in the study were identification of lab equipment, function of laboratory equipment, setting a microscope, handling of microscope, mounting of specimen on slide, focusing from low to high power, staining specimen, measuring weight in gm, mg and µg, measuring liquid in litre, ml and µl, drawing , and estimation of the diameter of a microscope. Measuring is basic (lower order) science process skills but is low. The result of this study is different from those of Moni et al. (2007). The results of Moni et al.(2007) showed that students are demonstrating proficient core laboratory skills on their first attempt for correct use of a micropipette, for preparation of dilutions using a micropipette, for correct use of a light microscope, and for proficient use of digital data.

The result of this study is in agreement with the results shown by Cushing (2002). Cushing (2002) studied that the mean score of microscope assessment and task assessment were low.

There was an assumption that students with better prior background in biology laboratory at secondary and preparatory schools would have higher biology laboratory performance test results than those without it but there was no significant correlation between high school lab background and laboratory skill performance test result. The result of this study supports that of Bone and Reid (2011).

Ochonogor (2011) stated that there is a significant difference in performance level between male and female biology education students in that the female students perform significantly better than the males. However, in this study, there is no significant difference in

laboratory practical performance level of male and female students. But the result of this study is in agreement with Jack (2013). A study conducted by Jack (2013), to find out the influence of selected variables, such as sex, on students' science process skills acquisition in Nigeria, revealed that sex, does not influence students' acquisition of science process skills.

Students' course achievement (CGPA) is a significantly and a positively related with laboratory skill performance test scores. The grade point average (CGPA) was also significantly and positively related with higher education entrance exam score ($p<0.000$). This may be due to students' academic background and individual differences.

Biology laboratory skill test score is not significantly correlated with prior high school and preparatory school biology laboratory background. This may be due to unstructured laboratory activities or investigations at high school and preparatory schools. However, correlation and multiple regression analyses revealed that students' laboratory performance skills are significantly positively correlated with higher education entrance exam score.

Conclusions and Recommendation

This research provides an overview of higher education entrance examination scores and is a predictor of student success and students' laboratory skill performance in undergraduate biology program irrespective of gender. The finding of this study revealed that scores in theory courses can be used to predict their scores in the practical courses. There is a significant and positive linear correlation between students' competences in practical skills and performance in higher education entrance examination scores. There is also a significant and a positive linear relationship between the students' cumulative grade point average (CGPA) with higher education entrance exam scores and biology laboratory skill test score. However, laboratory skill performance test score was not correlated with students' high school laboratory background and sex. Therefore, there is a need for more of this type of study with a larger sample size to examine why students' high school laboratory background has no relation with undergraduate laboratory skill performance. The study could also be extended to other programs such as chemistry and physics. The findings implicated that the Ministry of Education should foster secondary high schools and college preparatory schools to put greater efforts at preparing undergraduate admitted students for students' better outcome and their retention in universities.

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