

# How Science Prior Knowledge and Students' Assessment Affect Science' University Academic Achievements

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## Abstract.

The study aimed to investigate the relationships between the science prior knowledge, university assessment effectiveness, and science' university academic achievements of students at university. The correlational quantitative approach, the structured questionnaire, and a non-random sample of students were selected to be used in the study. The study found a moderate positive correlation between science prior knowledge and science' university academic achievements variables ( $r = .458$ ). It is also revealed that the total variance of science' university academic achievements explained by university assessment effectiveness level is 11.3%; the other variance may be explained by other variables

**Keywords:** Science prior knowledge, university assessment effectiveness, science' university academic achievements.

## 1. Introduction and literature review

The first year of the university is a critical year for the students' future academic success and achievements (Ribeiro, Rosário, Núñez, Gaeta, & Fuentes, 2019). Students' progress is one of the main objectives of university programs. Through academic achievement, the student builds up their talents and abilities to achieve their goals and create a successful professional performance (Arbabisarjou et al., 2016). Academic achievement represents a measurement of students' knowledge, skills, and abilities (Davison, & Dustova, 2017). Academic achievements are a direct and complex process of reflection of student engagement in the process of building a professional and socially successful future (Abdi, 2014). The main aim of the study is to investigate the relationships between the science prior knowledge, university assessment effectiveness, and science' university academic achievements of students at university. The research questions include: (1): Is there a significant relationship between the science prior knowledge and science' university academic achievements? (2) Is there a significant relationship between university assessment effectiveness and science'

university academic achievements? Is variance on science' university academic achievements explained by science prior knowledge and university assessment effectiveness?

### 1.1 Literature review

The relationships between the science' prior knowledge and science university academic achievements.

Different scientific studies during the last century are focused on identifying and analyzing the factors that can help to predict student academic achievements and student success (Arbabisarjou, et al., 2016). As Ausubel (1968) is saying "The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (Hansen, 2009). A variety of underlying factors are discussed in this context and a variety of predictors of success are identified. Many authors give data on this discussion underlying that the best predictor of student success and academic achievement in general and in natural sciences, in particular, is prior knowledge (Binder, et al., 2019; Chingos, et al., 2007; Tatar, et al., 2014). Based on Hailikari et al. (2007) there are four prior knowledge types relevant for achievement in the first year of university as follow: 1. knowledge of facts = low level of abstraction that can be tested through recognition and reproduction tasks; 2. knowledge of meaning = ability to understand the meaning of a concept; 3. integration of knowledge = ability to understand the relations and links between different concepts and phenomena; 4. application of knowledge = ability to apply knowledge and solve specific problems (Hailikari, Nevgi, & Lindblom-Ylänne, 2007). Eliciting students' ideas and prior knowledge in all its types is a primary step in teaching science (Lone, 1999). Prior knowledge of behavioral objectives promotes students' academic achievement. Teachers should give students behavioral objectives before the teaching of the concept (Udo, & Ubana, 2016). Students' prior knowledge influences the quality of the guidance that they get at university.

Research data shows that students with different levels of prior knowledge benefit from different types of guidance in a variety of ways based on their knowledge level (van Riesen, Gijlers, Anjewierden, & de Jong, 2018; Lone, 1999; Kalyuga, & Renkl, 2010). Prior knowledge affected individuals' development of factual knowledge and understanding (Cai, & Gu, 2019). Based on Tuovinen & Sweller, 1999, guidance helps to fill the gap of knowledge and skills, required to accomplish academic achievements and practical tasks. As literature data shows if an academic task is simple the students can succeed in the task with little or no guidance and in this way can start to build up an academic achievement (van Riesen, S. A., Gijlers, H., Anjewierden, A., & de Jong, T., 2018). It looks that additional guidance is a benefit for the students with a low level of knowledge and this guide helps them to achieve better academic results (Kalyuga & Renkl, 2010). Instead, students with a high level of prior knowledge, self-efficacy, and self-regulated learning obtain a better understanding and do not need additional guidance to achieve academic results (Cai, & Gu, 2019; Fulano, Magalhães, Núñez, Marcuzzo, & Rosário, 2020). Therefore, it is hypothesized that:

*The variance in science' university academic achievements in the university studies is been explained by the science prior knowledge.*

*The relationships between the university assessment effectiveness and science university academic achievements.*

Scientific studies found that students who deepen their knowledge in high school courses on subjects that are also part of the university curricula in the first year of the university, perform better than those who did not. For this reason, one of the indicators that are used by universities to predict academic achievement is high school grades for subject-specific prior knowledge. Literature data show that success in university is related also to the way scientific content is packaged and learned by the students at high school (Robbins et al., 2004), students with higher prior knowledge and higher grades from high school understand, remember and perform better in university, score successfully on exams and are more prepared to succeed (Chi & Ceci, 1987; Hailikari et al., 2007). Therefore, increasing the academic preparedness of students before getting to university is an important step toward academic achievement and student success in the university (Chingos, 2018). Those studies underlay also the role of prior knowledge assessment with a variety of assessment methods as a powerful tool to predict student success in university in general and in science courses in particular (Binder, Sandmann, Sures, Friege, Theyssen, & Schmiemann, 2019; Tatar, Tüysüz, Tosun, & Ilhan, 2016). To predict the university academic achievements and success in science subjects most universities use as an indicator of students' prior knowledge the high school grade point average and subject grades (Binder, Sandmann, Sures, Friege, Theyssen, & Schmiemann, 2019) because through them university can measure not only the prior knowledge of its students of the first year, but also can predict their university readiness (Binder, Sandmann, Sures, Friege, Theyssen, & Schmiemann, 2019; Chingos, 2018; Lone, 1999); Abdi, 2014; Udo, & Ubana, 2016). Prior knowledge assessment is also an important tool to guide students through academic achievement. To measure academic achievement, universities use different types of assessment that bring important information about the prior knowledge and learning process. Assessment of prior knowledge is supposed to be motivating and provide goals (Linn & Gronlund, 1995; Hargis, 2003). Assessments must include systematic teacher observation, in which tasks have to be assessed parallel with learning outcomes and activities performed to achieve them. Performance-based assessment is one of the strategies that help students to demonstrate their prior knowledge, apply skills, and perform behaviors. Performance-based assessments of prior knowledge, are more functional where into them blending approaches are included, where content is assessed together with processes, and concepts are treated as part of specific problems (Baron, 1991; Kober, 1993; Jorgensen 1993). Therefore, it is hypothesized that:

*The variance in science' university academic achievements in the university studies is been explained by the university assessment effectiveness.*

## 2. Methodology

The method used in the research was the quantitative approach. The correlational research design was used to test the research hypothesis. The respondents were selected using existed students in the first year of university studies of natural sciences faculty of the main university in the country.

*Sample and data collection*

The sample of the research has been compounded by first-year university students (N=99) of the natural sciences faculty of the main university in the country. A breakdown of a non-random sample of the respondents included 54 females (54.5%), and 45 (45.5%) males.

A structured questionnaire was used to gather primary data for science high school optional curriculum, knowledge coherence, and science academic success variables.

*Analysis*

The central tendency and frequency values were used to describe the science high school optional curriculum, knowledge coherence, and science academic success variables. The relationship between science high school optional curriculum, knowledge coherence, and science academic success was investigated using Pearson’ r correlation coefficient. The prediction of the science academic success by the science high school optional curriculum and knowledge coherence was investigated by linear bivariate and multivariate regression. The assumption testing was conducted to check for normality, linearity, outliers, as well as the homogeneity of variance-covariance matrices and multicollinearity, with no violations noted.

**Results and discussion**

Descriptive analysis:

Table 1: Science prior knowledge frequencies

<b>Science Prior knowledge</b>		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Math	16	16.2	16.2	16.2
	Physics	25	25.3	25.3	41.5
	Chemistry	33	33.3	33.3	74.8
	Biology	25	25.3	25.3	100.0
	Total	99	100.0	100.0	

Science prior knowledge frequencies variable frequencies showed that 16.2% of the respondents are reported to have the prior knowledge mainly in Math; 25.3% of them are reported to have the prior knowledge mainly in Physics; 33.3% of them are reported to have the prior knowledge mainly in Chemistry, and 25.3% of them are reported to have the prior knowledge mainly in Biology.

Therefore, 1/3 of students (33.3%) are reported to have prior knowledge mostly in Chemistry; ¼ of them (25.3%) are reported to have the prior knowledge mostly in Physics; another ¼ of them (25.3%) are reported to have the prior knowledge mostly in Biology; meanwhile, less than 1/5 of them (16.2%) are reported to have the prior knowledge mostly in Math.

In conclusion, the most of students have more prior knowledge in Chemistry, followed by Biology and Physics, and less prior knowledge in Math.

Table 2: University assessment effectiveness frequencies

<b>University assessment effectiveness</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	41	41.4	41.4	41.4
	Low	34	34.3	34.3	75.8
	Moderate	20	20.2	20.2	96.0
	High	4	4.0	4.0	100.0
	Total	99	100.0	100.0	

University assessment effectiveness variable frequencies showed that 41.4% of the respondents claimed the none effectiveness of assessment in teaching and learning; 34.3% of them claimed to consider low effectiveness of assessment; 20.2% of them claimed moderate effectiveness of assessment, and only 4.0% of them claimed high effectiveness of assessment in teaching and learning at university.

Therefore, less than half of students (41.4%) claimed the none effectiveness of assessment in teaching and learning, a little more than 1/3 of them claimed the low effectiveness of assessment, 1/5 of them claimed the moderate effectiveness of assessment and only 4.0% of them claimed high effectiveness of assessment in teaching and learning at university.

In conclusion, 2/3 of students claimed the none or low effectiveness of assessment in teaching and learning; meanwhile, 1/4 of them claimed the moderate or high effectiveness of assessment in teaching and learning.

Table 3: Science' university academic achievements frequencies

<b>Science' university academic achievements</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Math	20	20.2	20.2	20.2
	Physics	24	24.2	24.2	44.6
	Chemistry	27	27.3	27.3	71.8
	Biology	28	28.3	28.3	100.0
	Total	99	100.0	100.0	

Science' university academic achievements variable frequencies showed that 20.2% of the respondents are reported to have academic achievements in Mathematics; 24.2% of them are reported to have academic achievements in Physics; 27.3% of them are reported to have

academic achievements in Chemistry, and 28.3% of them are reported to have the academic achievements in Biology.

Therefore, approximately 1/3 of students (28.3%) are reported to have mostly academic achievements in Biology, a little less than 1/3 of students (27.3%) are reported to have the most academic success in Chemistry, less than 1/4 of them (24.2%) are reported to have mostly academic achievements in Physics; meanwhile, a1/5 of them (20.2%) are reported to have the most academic achievements in Mathematics.

In conclusion, the most number of students (28.3%) are reported to have academic achievements in Biology, followed by 27.3% of them that are reported to have academic achievements in Chemistry,24.3% of them that are reported to have academic success in Physics, and20.2% of them that are reported to have the academic success in Mathematics.

**Inferential analysis:**

H1

The variance in science’ university academic achievements in the university studies is been explained by the science prior knowledge.

*Table 4: Correlation outputs of the relationship between science prior knowledge and science’ university academic achievements variables*

<b>Correlations</b>			
		Science’ university academic achievements	Science Prior knowledge
Pearson Correlation	Science’ university academic achievements	1.000	.458
	Science Prior knowledge	.458	1.000
Sig. (1-tailed)	Science’ university academic achievements	.	.000
	Science Prior knowledge	.000	.
N	Science’ university academic achievements	99	99
	Science Prior knowledge	99	99

The outputs of the Pearson correlation indicate that there is a moderate positive correlation between science prior knowledge and science’ university academic achievements variables,  $r = .458$ ,  $n = 99$ ,  $p < .005$ . The value of correlation points out that increasing science prior knowledge values would increase the science’ university academic achievements level. So, there are a moderate positive correlation between science prior knowledge and science’ university academic achievements variables.

Table 5: R Square values of the relationship between science prior knowledge and science' university academic achievements variables.

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.458 <sup>a</sup>	.210	.202	.97678	.210	25.808	1	97	.000

a. Predictors: (Constant), Science Prior knowledge

The regression outputs show that the total variance of science' university academic achievements explained by science prior knowledge level is 20.2%, F (1, .976), p < .005. The other variance may be explained by other variables.

Table 6: Beta value of the relationship between science prior knowledge and science' university academic achievements variables

Coefficients <sup>a</sup>									
Model		Unstandardized Coefficients		Standardized Coefficients		Correlations			
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part
1	(Constant)	.697	.166		4.207	.000			
	Science Prior knowledge	.482	.095	.458	5.080	.000	.458	.458	.458

a. Dependent Variable: Science' university academic achievements

The control measure in the model is statistically significant with higher standardized beta values: beta = .458; p < .005). Therefore, the science prior knowledge predicts science' university academic achievements.

The result was consistent with previous literature works, who argued that science prior knowledge level influences the science' university academic achievements of students. Therefore, hypothesis 1: *The variance in science' university academic achievements in the university studies is been explained by the science prior knowledge*, is been supported

## H2

The variance in science' university academic achievements in the university studies is been explained by the university assessment effectiveness.

Table 7: Correlation outputs of the relationship between university assessment effectiveness and science' university academic achievements variables

<b>Correlations</b>			
		Science' university academic achievements	University assessment effectiveness
Pearson Correlation	Science' university academic achievements	1.000	.350
	University assessment effectiveness	.350	1.000
Sig. (1-tailed)	Science' university academic achievements	.	.000
	University assessment effectiveness	.000	.
N	Science' university academic achievements	99	99
	University assessment effectiveness	99	99

The outputs of the Pearson correlation indicate that there is a low to moderate positive correlation between university assessment effectiveness and science' university academic achievements variables,  $r = .350$ ,  $n = 99$ ,  $p < .005$ . The value of correlation points out that increasing university assessment effectiveness values would increase the science' university academic achievements level. So, there is a low to moderate positive correlation between university assessment effectiveness and science' university academic achievements variables.

Table 8: R Square values of the relationship between university assessment effectiveness and science' university academic achievements variables

<b>Model Summary</b>									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.350 <sup>a</sup>	.122	.113	1.02962	.122	13.527	1	97	.000

a. Predictors: (Constant), University assessment effectiveness

The regression outputs show that the total variance of science' university academic achievements explained by university assessment effectiveness level is 11.3%,  $F(1, .029)$ ,  $p < .005$ . The other variance may be explained by other variables.

Table 9: Beta value of the relationship between university assessment effectiveness and science' university academic achievements variables.

		Coefficients <sup>a</sup>							
		Unstandardized Coefficients		Standardized Coefficients		Correlations			
Model		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part
1	(Constant)	.995	.146		6.810	.000			
	University assessment effectiveness	.436	.119	.350	3.678	.000	.350	.350	.350

a. Dependent Variable: Science' university academic achievements

The control measure in the model is statistically significant with higher standardized beta value: beta = .350;  $p < .005$ ). Therefore, university assessment effectiveness predicts science' university academic achievements.

The result was consistent with previous literature works, which argued that university assessment effectiveness level influences the science' university academic achievements of students. Therefore, hypothesis 2: *The variance in science' university academic achievements in the university studies is been explained by the university assessment effectiveness*, is been supported

### 3. Conclusion and implications

The study aimed to investigate the relationships between the science prior knowledge, university assessment effectiveness, and science' university academic achievements of students at university. The prior assumption was that the science prior knowledge and university assessment effectiveness predict science' university academic achievements.

The study revealed that 33.3% of students show prior knowledge mostly in Chemistry; 25.3% of them mostly in Physics; another 25.3% of them mostly in Biology; meanwhile, less than 16.2% of them mostly in Math. It is found that 41.4% of students claimed then one effectiveness of assessment in teaching and learning, meanwhile, 58.6 of them claimed low, moderate, or high effectiveness of assessment in teaching and learning at university. The study also found that 28.3% of students reported mostly academic achievements in Biology, 27.3% of them in Chemistry, 24.2% of them in Physics, and 20.2% of them in Mathematics.

The study revealed a moderate positive correlation between science prior knowledge and science' university academic achievements variables ( $r = .458$ ). Meanwhile, the regression outputs show that the total variance of science' university academic achievements explained by science prior knowledge level is 20.2%; the other variance may be explained by other variables. The control measure in the model is also statistically significant with higher standardized beta values: beta = .458. Hence, the science prior knowledge predicts science' university academic achievements. It is indicated a low to moderate positive correlation between university assessment effectiveness and science' university academic achievements variables ( $r = .350$ ). It is revealed that the total variance of science' university academic

achievements explained by university assessment effectiveness level is 11.3%; the other variance may be explained by other variables. At the same time, the control measure in the model is statistically significant with a higher standardized beta value:  $\beta = .350$ . Thus, university assessment effectiveness predicts science' university academic achievements. Therefore, science departments at the university level should consider supporting students to increase the knowledge and skills in science, because it is confirmed by this study that the science prior knowledge, as well as university assessment effectiveness, affect science' university academic achievements of students at university.

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