

## The interplay between Teachers' Efficacy, Effectiveness, Attitudes and Students' Academic Achievement in Biology

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### Abstract

The purpose of this study was to determine the association between teachers' efficacy, teachers' effectiveness, attitude toward biology, and students' achievement in biology among lower secondary schools in Nyamagabe district, Rwanda. The study used an ex-post-facto research design to accomplish this. Eighty-eight respondents including 44 head teachers and 44 biology teachers were purposively selected from 46 schools as a sample. Data were collected using the Teacher Efficacy Scale (TE), Teachers Attitude towards Teaching Biology Questionnaire (TATBQ) for teachers, and Biology Teacher Effectiveness Questionnaire (BTEQ) for headteachers. Besides, the 2018 Biology National Examination 2018 results were used as a measure of student academic performance in biology. The Pearson Correlation and Multiple Regression analyses were used in the data analysis. Correlation results revealed a positive and significant relationship between the teachers' attitudes towards teaching biology, efficacy and effectiveness, and student's academic performance in biology. Multiple regression analysis indicated that teachers' attitudes, efficacy, and effectiveness have a positive contribution to the model. It was concluded that good biology knowledge, efficacy, and effectiveness, as well as biology teachers' positive attitudes, are key elements that, when combined, are thought to lead to greater academic success in biology in lower secondary schools. It was recommended, among other things, that school officials should monitor and supervise classroom teaching and learning at their schools regularly to ensure that teachers are performing their tasks properly. Teachers should be exposed to professional advancement programs such as seminars, workshops, and retraining to develop a more positive attitude towards the teaching of Biology and to improve their teaching strategies.

Keywords: students' academic performance; attitude, biology teachers; teacher effectiveness; teacher efficacy; teachers' attitudes

### Introduction

In today's contemporary era, science has been globally considered an indispensable tool of any nation's progress in different aspects of life (Buah & Akuffo, 2017). In line with this perspective, Ogunye and Fasakin (2011) stressed the relevance of scientific knowledge in enhancing the country's military prestige, national wealth, and international standing. This would suggest that improving science education at all levels of education is critical

as it will lead to socio-economic and technological advancements, especially in the developing world.

Biology education is one among other branches of science education in which knowledge is essentially needed for a nation's technological advance. Without biology knowledge, the much-needed technological development may not be achieved. The knowledge of biology is brought to play in the manufacturing and processing industry of

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medicine, pharmaceuticals, foodstuffs, insecticides among others (Rwanda Education Board,[REB], 2015). Moreover, the recent signs of progress recorded in biochemistry, physiology, ecology, genetics, and molecular biology are in line with biological knowledge and application (Joda, 2019). Furthermore, biology plays an important role in finding solutions to the problem of food security, environmental pollution, population explosion, climate change, disease outbreak as well as natural resources conservation among others (Osuafor & Amaefuna, 2016).

Due to its importance to mankind, the government of Rwanda and its partners have put efforts to improve Biology teaching at all levels of the education system. These include the reform of the curricula, regular teacher training, and provision of materials for practical teaching of science and ICT, the rehabilitation and construction of new Biology laboratories amongst others (REB, 2015). Besides, the Science and Technology policy within education in Rwanda emphasizes the teaching and learning of biology at all the tiers of education. At the primary level, the subject appears in the name of Science and Elementary Technology (SET). In secondary school, it is called "Biology". Although in Tertiary education it is still biology, the subject in some cases extends to disciplines like Anatomy, Botany, Zoology, Microbiology. It is equally central to science-related courses such as Medicine, Pharmacy, Agriculture, Nursing, Biochemistry among others (REB, 2015).

According to REB (2015), at a lower secondary level, biology is introduced as a core subject where career abilities are groomed, and potential talents are discovered and energized. Besides, the knowledge and skills learned from lower-level biology contents are the prerequisite of the materials

to be studied in biology-related combinations at the upper secondary level, and in some important biology-related fields at the tertiary education level.

Despite the importance of biology in Rwandan education and the multiple benefits that studying biology provides for both individuals and the country, efforts to increase the quality of biology teaching and learning have not generated the expected results. This is because the students' performance in the National Examination in biology is still discouraging compared to other science subjects. This has, in one way or the other, inhibited the advancement of science and technology in the country. The poor performance in Biology is reflected by the decline observed in Senior Three National Examination (S3NE) performance over the years. According to the Ministry of Education [MINEDUC] (2012), the percentage of students who failed biology in S3NE was 35.9% and 36.4% in 2009 and 2010 respectively. Besides, the student's poor performance in biology cuts across almost all districts in Rwanda, and the percentage of students failing in the subject is high. For instance, the critical look of the results of the S3NE National Examination in biology in 2019 among lower public secondary schools in the Nyamagabe district indicated that only 51% obtained credit passes while 49% failed (The Republic of Rwanda, 2018). Similarly, Ntawiha (2016) discovered that biology was performed poorer in public secondary schools in Rwanda's Nyarugenge and Nyamasheke districts than Chemistry and Physics in S3NE.

This situation raises the question of whether or not students' performance in the subject is a reflection of the quality of teachers as well as the teaching approach used by secondary school biology teachers. This viewpoint is shared by Ibukun (2009), who claims that no

educational system can outperform the quality of its teachers. This is because, through their interactions with students, teachers are the ones who accept and implement the curriculum designers' ideas and objectives on the ground. Consequently, any educational system will be more effective if the teachers are better qualified. Thus, a need arises to establish whether biology teachers' efficacy, effectiveness, and attitude towards biology teaching correlate with the student's performance in biology in S3NE.

Some recent investigations into factors responsible for students' academic performance in Rwanda focused mainly on school management strategies (Mbonyumuvunyi, 2015), in-service secondary school teachers education (Harerimana et al., 2017), educational inputs (Ntawiha, 2016), the medium of instruction (Bagabe, 2015; Lackamp, 2016), and teaching techniques (Byusa et al., 2020). What has been overlooked however is the need to investigate how the teachers' effectiveness, efficacy, and attitudes towards subject teaching, determine students' academic performance. Given this knowledge gap, this study was proposed to fill it. Understanding how these variables relate to students' biology academic performance will assist various educational stakeholders in developing policies aimed at improving biology teaching and learning efficiency, particularly in lower secondary schools, by focusing on the most effective interventions.

## Literature Review

### *Teachers' Efficacy and Students' Academic Performance*

Efficacy is described as one's belief in one's capacity and competence to complete a task or deal with environmental pressures, according to Bandura's (1997) social-cognitive paradigm. It is the ability to organize social, technical, and behavioral

skills to achieve goals at work (Bandura, 1997). According to the literature, efficacy belief plays a significant effect on psychological and physical health outcomes. People with high efficacy, for example, reported less work stress and strain, according to O'Leary (1992).

In addition, Ghaderi and Salehi (2011) discovered a relationship between low efficacy and high stress and anxiety levels. When efficacy is used in the context of teaching, researchers come up with Teacher Efficacy (TE). As a result, teacher efficacy relates to the ability to identify the consequences of students' work, as well as the teachers' self-belief in their pedagogies' trust and capacities to accomplish instructional duties (Tschannen-Moran & Hoy, 2001). Teachers with high efficacy are confident in their ability to successfully impart knowledge to students.

In this regard, teachers with a pronounced sense of efficacy beliefs are more open to new ideas and more willing to exploit new instructional methods to better meet the needs of their students (Bruce et al., 2010). Furthermore, they tend to believe that the students' problems may be handled with appropriate support, activities, and assessment methods (Garca-Ros et al., 2015). Teachers with low efficacy, on the other hand, believe they have less power over their pupils and, as a result, are less engaged in the classroom (Sivri & Balç, 2015), and are less likely to produce positive student outcomes (Garca-Ros et al., 2015).

It is obvious from the preceding assertions that the teacher must possess efficacy, as well as other attributes such as confidence, to complete his or her duty. Furthermore, teachers must not only understand the importance of efficacy beliefs but also implement them in their classroom activities to have high-performing students. Therefore, teachers' efficacy has a strong impact on the

teaching and learning process as well as on students' learning outcomes.

Several researchers have looked into the impact of teacher efficacy on student academic performance (Shahzad & Naureen, 2017; Huber et al., 2016; Bruce et al., 2010; Ahmad et al., 2015). All of these studies found a significant relationship between instructors' efficacy (student engagement, classroom management, and instructional methods) and students' academic performance.

*Teacher's Effectiveness and Students' Academic Performance*

A teacher's effectiveness has been variously defined by researchers because there is little or no agreement on what a good teacher should be. Accordingly, Evans (2006) defined teacher effectiveness as teacher's personalities, teacher-student interaction, and teacher's impact on students' behavior. To Diamond (2004), a teacher's effectiveness is the ability to produce desired results. Hughes (2001) viewed that effectiveness as the process of teacher's interaction with students in educating them and students' performance in tests and examinations. This effectiveness is viewed on the ability of the teacher to employ appropriate instructional methods and strategies to impart the learner's knowledge, skills, and competencies required for bringing desired learning outcomes. A teacher's ability is measured in terms of how well the learning process can be maximized among the students.

From the above teacher effectiveness traits, the quality of any educational program cannot exceed the effectiveness of competent teachers. Effective teachers are those who meet the objectives that they set for themselves or those others, such as ministries of education and school/college administration, establish for them. Teachers

must have the information and abilities necessary to fulfill the prescribed goals to be effective. If these objectives are to be met, they must also be able to use their knowledge and abilities effectively (Adegbile, 2008). According to the author, a teacher should be able to use acceptable teaching strategies, demonstrate requisite pedagogical insight and professional skills, and use them to steer the teaching and learning process to attain stated educational objectives.

The literature review reveals the characteristics of an effective teacher and effective teaching. For instance, according to Badau (2016), an effective teacher must not only stress the knowledge, competence and skills desired to attain the educational goals and objectives but also must be able to use these skills and competencies. Similarly, Abdu (2012) opined that a teacher must possess a variety of knowledge such as that of content, curriculum, general pedagogical, learners and their characteristics, pedagogical content, educational context, educational ends, purpose, and values. These denote that teachers must not only be life-long learners of the subject matters and performers but must also know how to manage their classrooms, give constructive feedback, and make wise decisions and practical plans.

Furthermore, Akomolefe (2010) identified the following characteristics of effective teaching: attention to students' achievement, quality teaching responsive to students' learning processes, effective and efficient learning opportunities, pedagogical practices that create a cohesive learning environment, effective links between school and the cultural context of the school, multiple tasks to support learning cycles, effectively aligned curriculum goals, and pedagogy scaffolds feedback.

Various empirical studies have linked teachers' effectiveness and students' learning outcomes. Jaafari et al. (2012) averred that teachers with high effectiveness use the classroom efficiently, practice things that are associated with students' achievement and enhance the feature of efficacy in their performance. In addition, according to Uduak and Bassey (2015), despite major advances in technology in all areas of the teaching and learning process, a teacher's efficacy is still a necessary and significant factor in transmitting knowledge to learners at all levels of education. According to Badau (2016), learners who are repeatedly assigned to ineffective teachers have worse learning and academic accomplishment than students who are repeatedly assigned to highly competent teachers. According to Kindley (2016), teachers with a strong sense of effectiveness, as well as high efficacy, have an easier time creating cognitive improvement in their students.

Adu (2015) conducted a correlational study of teacher effectiveness variables and students' academic achievement in economics. The study revealed that instructional activities (lesson planning, lesson delivery, communication, and use of questions, use of praise and reward, classroom management, use of instructional materials, knowledge of subject matter, evaluation techniques, and assignment), teacher personality traits, and attitudes and co-curricular activities all make a relative and composite contribution to the students' academic achievement in Economics as well as can predict the students' success in the subject.

Similarly, Akiri (2013) determined the effects of teachers' effectiveness on students' academic performance in public secondary schools in Nigeria. The study revealed that effective teachers produced better-performing students. In the same vein, Oviawe (2016) investigated the relationship between

teachers' effectiveness and students' academic achievement in Basic Technology in Edo State, Nigeria. From the findings of this study, it was included that teachers' effectiveness influenced students' performance.

#### *Teachers' Attitudes and Students Academic Performance*

Various researchers stressed that a teacher's attitude towards teaching science is one of the key factors in quality teaching and learning of science and outcomes (Gbore & Daramola, 2013; Kamal & Gbadamosi, 2014). An opinion or general emotion about something is defined as an attitude (Rooney, 2003). In addition, Hornby (2011) defined attitude as one's thoughts and feelings toward someone or something. Similarly, Khan and Ali (2012) claimed that attitude is a hypothetical construct that shows a person's likes and dislikes for a particular thing. It could be favorable, unfavorable, or neutral.

According to the literature, there are three different types of attitudes. Cognitive (knowledge), affective (emotions, feelings), and behavioral (activity) components are included (Maio & Haddock, 2018). What the individual thinks or believes about the attitude object is the cognitive component of attitude. The emotional component of an attitude refers to the individual's feelings or emotions about the attitude object. The behavioral component is the respondent's predisposition to react to the attitude object in a specific way. As a result, the cognitive, affective, and behavioral aspects of attitude are linked and intertwined.

Attitude can be learned or acquired via family members, teachers, and peers (Gbore & Daramola, 2013; Omoniyi & Olubunmi, 2016). As role models to the students, teachers' behaviors are easily imitated by students. This is in line with Ogembo et al. (2015) who argued that what teachers like or dislike, appreciate, or disapproves of, and

how they feel about their teaching and learning or studies could have a significant effect on their students. Thus, as the teachers develop a negative attitude towards subject teaching such as biology, they may influence the development of negative attitudes by the students towards learning biology, which results in poor academic performance.

In the science teaching context, Van Aalderen-Smeets et al. (2011) reported that teachers with negative attitudes towards teaching science spend a few hours teaching science, and tend to rely on planning by others. In contrast, Ulug (2011) found that teachers' positive attitudes have a favorable impact on students' personalities as well as their academic achievement. Furthermore, according to Ogembo et al. (2015), teacher attitudes have an important influence on the teaching and learning process.

A good number of research findings have found a correlation between teachers' attitudes either towards school subjects or towards subject teaching and students' academic performance. Daviran (2015), for example, looked into the impact of students' and teachers' educational attitudes on the academic achievement of third-grade middle school students in Zanjan, Iran. The study found that both attitudes of teachers and students impact students' academic achievement. The study concluded that students whose teachers have a positive attitude towards teaching performed better than their counterparts.

Madukwe et al. (2019) looked into teacher attitudes as a predictor of biology and geography students' academic success. Their findings demonstrated that teachers' attitudes regarding these subjects and how they were taught were positively and significantly associated with students' academic performance.

Similarly, Endurance and Tamunosis (2020) found that teachers' attitudes toward teaching have a considerable impact on students' attitudes regarding basic science. Teachers' attitudes were found to have a strong favorable association with students' academic performance in basic science, according to the study. In a similar line, Kamal and Gbadamosi (2014) concluded in their study on the effect of teachers' attitudes toward chemistry teaching that teachers with positive attitudes had greater student performance than those who did not.

However, in their study on the effects of teacher characteristics and attitudes on student achievement in economics, Kurgat and Gordon (2014) discovered that teachers in Kenya have a positive attitude toward the subject, implying that poor performance could be attributed to other factors other than teacher attitudes.

From the above-reviewed studies, it is clear that teachers' attitudes towards teaching science (biology) are important as they influence their teaching which in turn affects student achievement in the subject. However, given that findings on the effect of teachers' attitudes on students' performance are contradicting, an investigation into the relationship between biology teachers' attitudes towards biology teaching at the lower secondary school level is worthwhile.

The reviewed literature comprised various studies that reported a positive correlation between teacher efficacy, effectiveness, and attitude towards biology teaching and academic performance. However, nothing is known regarding the association between these variables and students' academic performance in biology in Rwanda, particularly in the Nyamagabe district, where performance has been declining. The purpose of this research was to determine how these

variables are associated with students' academic performance in biology among Rwandan lower secondary schools. The following research questions were specially addressed in this study:

1. What relationship exists between teachers' efficacy, effectiveness, and attitude, and their students' academic performance in Biology?
2. What are the relative contribution of the teachers' efficacy, effectiveness, and attitude to students' academic performance in Biology?
3. What are the composite contribution of teachers' efficacy, effectiveness, and attitude to students' academic performance in Biology?
4. Which of the three teacher factors (i.e., efficacy, effectiveness, and attitude) predict students' academic performance in Biology?

**Methodology**

*Research Design*

The research design employed for this study was ex-post facto. This is because the study variables are already in existence and their manifestations had already occurred

(Creswell, 2014).

*Research Participants*

The participants of this study included two groups. Table 1 displays the characteristics of headteachers and teachers who participated in this study.

The first group population comprised 44 headteachers and 44 biology teachers in the public secondary schools of Nyamagabe district, Rwanda. The criteria for selecting teachers was defined by having three years or over of teaching experience in biology at that level and having taught students who sat for the 2018 Biology National Examination. The second group includes the senior three students (SS3) in the same schools of the teachers in the 2018 academic year in Nyamagabe district, with a total of 3,112 (including 1,415 males and 1,697 females) whose teachers participated in this study.

*Data Collection Instruments*

To measure teacher efficacy, the researchers adapted Teacher Efficacy Scale (TES) developed by Tschannen-Moran and Hoy (2001). The instrument was designed for biology teachers and consisted of 24 items that evaluated the teacher's belief in his or her ability to effectively regulate instructional

*Table 1 Demographic profile elements of Headteacher and Teacher participants*

Profile elements	Headteachers		Biology Teachers		
	N	%	N	%	
Gender	Male	40	90.9	42	95.5
	Female	4	9.1	2	4.5
	Total	44	100.0	44	100.0
Age in years	30-34	0	0	4	9.1
	35-39	3	6.8	7	15.9
	40-44	19	43.2	14	31.8
	>45	22	50.0	19	43.2
	Total	44	100.0	44	100.0
Teaching experience in years				4	9.1
				16	36.4
				24	54.5
Total	44	100.0	44	100.0	

tactics (8 items), classroom management (8 items), and student involvement (8 items). The original TES contains 9 points to score each remark at first, with 1 indicating nothing and 9 indicating a lot. However, the scale was changed to a five-point Likert scale from nothing (1) to a great deal for the convenience of research participants (5).

The second instrument used was the Biology Teachers' Effectiveness Questionnaire (BTEQ). The questionnaire was adapted from Achimugu (2016) and was designed for school headteachers to evaluate the teaching effectiveness of biology teachers in their respective schools. The instrument consisted of 21 items on a four-point Likert scale of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD) on the instrument.

The third instrument was the Teacher Attitude towards Teaching Biology Questionnaire (TATBQ). The TATBQ items were adopted from the Relich and Way (1992)' Teacher 'Attitudes to Teaching Mathematics Survey. The term "Mathematics" in the items was replaced by "Biology", then these items were reviewed by specialist biology teachers, and necessary

modifications were done on items. The instrument has 20 items requiring Likert scale responses ranging from strongly agree to strongly disagree. Besides, it has 11 items related to the determination of attitudes towards the teaching of biology while the other 9 are about attitudes towards biology. Table 2 presents the sample items for each instrument used in this study.

#### *Validity and Reliability of Research Instruments*

The validity of the research instrument is one of the most common and important features of research used to estimate what the instrument is supposed to measure (Fraenkel et al., 2011; Johnson & Christensen 2013). Fraenkel et al. (2011) suggest that content validity needs to be evaluated by experts. They must check among others the content, the clarity of printing, the format, and the appropriateness of the language of the instrument. For this study, the content and face validity was ascertained by two experts in the field of teacher education, evaluation, measurement, and one expert in English, respectively. Two of them were from the Protestant University of Rwanda and another from the University of Rwanda-College of

*Table 2 Sample Items of the Data Collection Instruments*

<b>Instruments</b>	<b>Sample items</b>
Teacher Efficacy Scale (TES)	To what extent can you use a variety of assessment strategies? To what extent can you provide an alternative explanation or example when students are confused?
Biology Teacher Effectiveness Questionnaire (BTEQ)	The Biology teacher has a good knowledge of Biology as a subject The Biology The teacher always make use of his/her lesson plans in teaching
Teacher Attitude towards Teaching Biology Questionnaire (TATBQ)	I am not the type of person who could teach Biology very well I do not enjoy having to teach Biology.



Education. They checked whether items in the questionnaires were clear and easily understandable for secondary school headteachers and teachers. Their suggestions and corrections resulted in the final draft used in this study. The reliability of BTEQ was ensured by trial testing it on ten (10) headteachers while TSES and TATBQ were pilot-tested on twenty (20) Biology teachers who were not part of the sample.

The Cronbach alpha coefficient was used to estimate reliability. Cronbach's alpha reliability estimates for TSES, BTEQ, and TATBQ were determined to be .74, .82, and .80, respectively. These Cronbach's alpha values exceed 0.7 which indicates appropriate reliability (Creswell, 2014). The comparison of the reliability test results with the literature (Bal-Taştan et al., 2018; Mojavezi & Tamiz, 2012; Shahzad & Naureen, 2017) for TSES also indicates that the scale is satisfactory with acceptable reliability. The literature (Achimugu, 2016, Relich & Way, 1992) indicates the reliability of BTEQ and TATBQ to be satisfactory and with accepted reliability.

#### *Data Collection and Analysis*

The data collection process started in early September and ended by the end of October 2020. In this period many public and private Rwandan schools were in lockdown due to COVID -19 pandemic. However, people were highly encouraged to work from home by the use of information communication and technology (ICT) tools. To this effect, headteachers of secondary schools were first contacted using their mobile phones and emails as well as WhatsApp telephone numbers obtained from the District Education office in Nyamagabe district. The purpose was to explain the purpose, objective of the study, and the convenient way of data collection. Also, headteachers were requested to connect us to their biology teachers to allow us to administer the questionnaires via

emails or WhatsApp. The participants were given a copy of their questionnaire to respond to. The instruments were sent via electronic mail address and WhatsApp. Each of the respondents has been given a date for the questionnaire return. Moreover, a follow-up reminder was sent to all respondents who failed to respond by the specified date. For data analysis, the collected data were entered into the Statistical Package for Social Sciences (SPSS) version 21.0, to produce required tables of inferential statistics.

The academic performance of students in Biology was assessed using students' grade scores obtained in biology in the Biology National Examination in the 2018 school year. In Rwanda, the educational system, grade scales range between 1 and 9 points, and 8 is the cut-off point to pass (REB, 2013). The students' grade scales were distributed as follows: a value of 1 was assigned for grade scales between 1 and 2 (distinction); a value of 2 was assigned for grade scales between 3 and 6 (credit), a value of 3 was assigned for grade scales between 7 and 8 (pass), and a value of 4 was assigned for grade scale 9 (fail).

Data collected were subjected to correlation and regression analyses. Correlation analysis was used to explore the relationship between the teachers' attitudes toward teaching biology, teacher efficacy, teacher effectiveness, and student's academic performance in biology. The correlation coefficients were computed along with these variables.

Besides, multiple regression analysis was conducted to evaluate how well the students' academic performance can be predicted from their teachers' attitude towards teaching biology, efficacy, and effectiveness. The assumptions were examined and determined to be tenable for the application of correlation and multiple regression analysis before putting the variables to correction and

multiple regression analysis. To do so, we tested to see if the data on the predicted and independent variables were normally distributed. We also looked to see if the independent variables had a relationship with the dependent variable, with all correlation coefficients being more than 0.3 (Pallant, 2001). All of the independent variables and academic performance in this study demonstrated a positive correlation between students' academic performance with correlation coefficient values higher than 0.3. Besides, The bivariate correlations among predictors should be less than 0.7, according to Tabachnick and Fidell (1996). For this study, the correlation coefficient values between students' academic performance and the predictors (teachers' attitude, efficacy, and effectiveness) were no higher than 0.7. Furthermore, the VIF values were acceptable

TE=Teacher effectiveness

TA= Teacher attitude

$\beta_0$ = Constant (Coefficient of intercept)

$\beta_1$ , the regression coefficient of each variable expressed above

$\epsilon$ = Residual term

The correlation and regression analyses were the suitable techniques for data analysis because the study described the implications of predictor variables (teacher's efficacy, effectiveness, and attitude) for criterion variables (students' academic performance (Creswell, 2014).

### Results

Table 3 shows the descriptive statistics of the study variables (Academic performance (AP), Teacher Attitude (TA), Efficacy (TS), and Effectiveness (TE)).

*Table 3 Descriptive Statistics and Psychometric indicators of Study variables*

Variables	N	Min	Max	Mean	SD	Sk	Ku
Academic performance	3112	1.00	5.00	3.046	.95	-.24	-1.43
Attitudes	44	33.00	77.00	57.84	11.70	-.12	-1.13
Efficacy	44	33.00	84.00	58.13	15.47	.21	-1.16
Effectiveness	44	27.00	82.00	44.63	13.56	.97	.405

Note. N – Number of participants; Min – minimum; Max – maximum;; SD – standard deviation; Sk – skewness; Ku – Kurtosis.

(below 10), indicating that there was no multicollinearity problem, allowing the multiple regression analysis to be performed and the findings appropriately interpreted.

The model regressed academic performance on teacher efficacy, effectiveness, and attitude is as follows:

$$AC = \beta_0 + \beta_1TSE + \beta_2TE + \beta_3TA + \epsilon$$

Where

AC= Academic Performance

TSE= Teacher efficacy

It can be observed from Table 3 that on average, teachers displayed a greater efficacy (M=58.12) than attitude (M=57.91) and effectiveness (M=44.63). Besides, the descriptive statistics of the study variables show that the distribution of the results was found to be normal (skewness varies between -.12 and .97 and kurtosis between -1.13 and .405).

### Correlation Analysis

To establish the extent to which teacher efficacy, effectiveness, and attitude correlate with students' academic performance in regression analysis was applied. The findings are summarized in Table 4.

*Table 4 Intercorrelations among Teacher's attitudes, Efficacy, Effectiveness, and Students Academic Performance in Biology*

Variables	AP	TA	TS
Academic performance (AP)	-		
Teacher attitude (TA)	.607**	-	
Teacher Efficacy (TS)	.621**	.568**	-
Teacher effectiveness (TE)	.513**	.314*	.469**

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

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

Biology, Pearson correlation analysis between the study variables was computed and presented in Table 4. The results of the multiple regression analysis indicated that teachers' attitudes towards teaching biology, efficacy, and

*Table 4 Multiple Regression Results*

Model	R	R Square	Adjusted square	Std. Error of the Estimate
1.	.731 <sup>a</sup>	.535	.500	.933448

  

Model	Sum of squares	Df	Mean of squares	F	P-value
Regression	40.058	3	13.352	15.324	.000 <sup>b</sup>
Residual	34.853	40	.871		
Total	74.909	43			

a. Criterion Variable: Academic performance

The correlation results show that teacher attitude towards teaching biology had a positive correlation with the students' academic achievement ( $r = .607$ ), teacher efficacy ( $r = .621$ ), and teacher effectiveness ( $r = .513$ ). besides, the teacher attitudes were significantly positive in terms of their correlation with teacher efficacy ( $r = .568$ ), and teacher effectiveness ( $r = .469$ ). The results imply that students taught by teachers with positive attitudes towards teaching biology, with a high level of efficacy and effectiveness outperformed students taught by teachers with a negative attitude, a lower level of efficacy, and less effective biology teachers.

*Multiple Regression Analysis*

To fully understand the relationship between teachers' variables (TA, TS, and TE), and student's academic performance in biology,

effectiveness contributed to the students' academic performance in biology, (Adjusted  $R^2 = .53.5$ ,  $F(3, 40) = 15.324$ ,  $p = .000$ ,  $p < .05$ ). This finding indicated that approximately 53.5 percent of the variance in the students' academic performance can be accounted for by the linear combination of the teachers' attitudes, efficacy, and effectiveness. The remaining 46.5% could be due to factors or errors not considered in the study.

To explain the isolated contribution of the teacher variables to the academic performance in biology, the TA, TS, and TE were considered as independent variables, and the multiple regression analysis was separately performed for the dependent variable (AP). The findings are presented in Table 5.

*Table 5 Unique Analysis of R<sup>2</sup> Statistics for TA, TS, and TE and Academic Performance*

Component	Coefficient of Determination (R <sup>2</sup> )	
	Academic Performance	p-value
Unique to teacher attitude (TA)	.368	.000
Unique to teacher efficacy (TS)	.386	.000
Unique to teacher effectiveness (TE)	.264	.000

The finding in Table 5 shows that teachers' attitudes towards teaching biology accounted for 36.8% of the total variance ( $R^2 = .368$ ) in the academic performance in biology. The teachers' efficacy accounted for 38.6 % of the total variance ( $R^2 = .386$ ) in the academic performance in biology. On the other hand, the teacher effectiveness accounted for 26.4% of the total variance ( $R^2 = .264$ ) in this aspect. Thus, from this finding, the independent variables (TA, TS, and TE) had a significant influence on the total variance in academic performance.

From the model of the predictor variables shown in Table 6, the teacher attitudes to teaching ( $\beta = .357$ ;  $p < 0.05$ ), teacher efficacy ( $\beta = .295$ ,  $p < 0.05$ ) and teacher effectiveness ( $\beta = .263$   $p < 0.05$ ) could predict students' performance in Biology.

$AP = \beta_0 + 0.357(TA) + 0.295(TSE) + 0.263(TE) + \epsilon$  As a result, the strongest significant predictor of students' academic achievement in Biology is teachers' attitude toward teaching Biology.

### **Discussion of the Findings**

The purpose of this study was to investigate the association between teacher attitudes towards teaching biology, efficacy, and effectiveness and students' academic achievement in biology among lower secondary school students in Nyamagabe district, Rwanda.

The study finding revealed that there was a positive and significant correlation between teachers' attitudes and students' academic performance in biology. This finding could be explained by the fact that attitude is a

*Table 6 Teachers Attitudes, Efficacy, and Effectiveness as Predictors of Academic Performance in Biology*

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
1					
(Constant)	-2.477	.767		-3.231	.002
Attitudes	.040	.015	.357	2.717	.010
Efficacy	.025	.012	.295	2.091	.043
Effectvenesss	.026	.012	.263	2.150	.038

However, the teachers' attitude to teaching Biology has higher predicting power than teachers' efficacy and teachers' effectiveness. The regression equation deliverable from Table 5 is:

continual phenomenon that has a significant impact on human behavior. This is in line with Smith (1993) who stated that teachers' attitudes toward their profession will influence their pedagogical practices, which

will influence students' learning outcomes. In other words, a teacher with a strong positive attitude toward teaching will be able to favorably impact his or her students more than a teacher with a poor attitude toward teaching as a profession, regardless of other considerations. This finding is in line with Gbore and Daramola's (2013), Akinfe et al.'s (2012) findings, which indicated that among the teacher variables, the teachers' attitudes toward the subject are the most important determinant of students' biology performance. In another school subject, Ekperie (2019), Shittu and Oanite (2015), Wilmot and Otchey (2012) discovered that teachers' attitudes toward teaching geography and social studies respectively were a crucial factor of students' academic achievement. This finding is also in line with Daviran (2015), Endurance and Tamunosis (2020), Kamal and Gbadamosi (2014), who suggest that teachers' favorable attitudes toward teaching are linked to students' academic performance in science. However, this finding contradicts Kurgat and Gordon's (2014) findings, which found no correlation between teachers' attitudes toward teaching and students' achievement in Economics.

The result of this study also revealed a significant and positive correlation between teachers' efficacy and student academic performance in Biology. This means that if teachers believe they can influence student academic success, they will be more enthusiastic about teaching, which may have a favorable impact on student achievement. This finding is consistent with previous studies such as Ahmad et al. (2015), Bruce et al. (2010), Cardenas and Cerado (2016), Huber et al. (2016), Shahzad and Naureen (2017), who found in their studies that teacher efficacy influences favorably students' learning outcomes. The findings of Bal-Taştan et al. (2018), who discovered that teacher efficacy had a significant impact on academic achievement, also support the

study's findings. However, this finding contradicts that of Nouf (2015) which revealed that there was no significant relationship between mathematics and science teachers' sense of efficacy and their students' academic performance.

Moreover, the findings showed a statistically significant relationship between teacher effectiveness and student academic performance. This suggests that teacher's effectiveness leads to the full realization of effective teaching and learning process, which in turn impacts positively student's academic performance. This is supported by Oliver and Reschly (2007), Orji (2014) who submitted that effective teaching and learning process leads to better student learning outcomes. The finding concords with the finding of the research conducted by Adeniyi (2020), Akiri (2013), Oviawe (2016) who found a positive correlation between the teachers' effectiveness and students' academic performance in different school subjects.

Likewise, the findings demonstrated that a linear combination of the teachers' efficacy, effectiveness, and attitude toward Biology explained 53.5 percent of the variance in academic achievement in Biology. It was also discovered that biology teachers' attitudes toward biology instruction, followed by efficacy and effectiveness, were the best predictors of students' success. These findings are consistent with the findings of Gbore, and Daramola (2013), Wilmot and Otchey (2012), that teachers' attitudes towards teaching biology and mathematics explained more of the total variance in students' performance in these subject courses.

Finally, the findings of this study revealed that teacher attitudes, efficacy, and effectiveness were the significant predictors of student academic performance in biology, with attitudes, being the best predictor followed by efficacy and effectiveness. This

result supports the previous studies that addressed the influence of teacher attitude, efficacy, and effectiveness on students' academic performance (Akiri, 2013; Olagbaju, 2020; Oviawe, 2016; Tella, 2008).

### **Conclusions**

Based on the findings of this study, it was determined that students' academic success in biology in 2018 S3NE in Nyamagabe district, Rwanda is related to teachers' attitudes toward teaching biology, their efficacy, and effectiveness. From these findings, it was concluded that good biology knowledge, efficacy, and effectiveness, as well as biology teachers' positive attitudes, are key elements that, when combined, are suggested to lead to greater academic success in biology in lower secondary schools. This generally implies that for students' academic performance to increase, biology teachers are expected to possess a positive attitude towards teaching the subject. Besides, they have to maintain a good relationship with students, good classroom management, student engagement, and effective selection and control over instructional strategies used. Moreover, teachers need to have good knowledge of the subject matter coupled with a positive attitude towards biology teaching. They have also to use appropriate teaching strategies and teaching materials.

### **Recommendations**

- Teachers should be helped to develop a more positive attitude towards the teaching of biology and to improve their teaching strategies through regular seminars, training, and workshops;
- To guarantee that biology teachers perform their tasks effectively, school headteachers and Deputy Head Teachers in charge of studies should conduct regular and stringent

monitoring and supervision of classroom teaching and learning processes.

- Biology teachers must build strong relationships with their students and focus on classroom activities that promote active teaching as well as the active involvement of students in class;
- Secondary school headteachers, in collaboration with other educational stakeholders, could organize school-based training sessions on the use of innovative teaching strategies, improvisation of instructional materials, and assessment techniques to be used by their teachers regularly.
- Additional research should be done to look at other drivers of students' academic achievement in biology that were not looked into in this study, such as gender, school location, and teacher motivation in secondary schools in the study area or other Rwandan districts.

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